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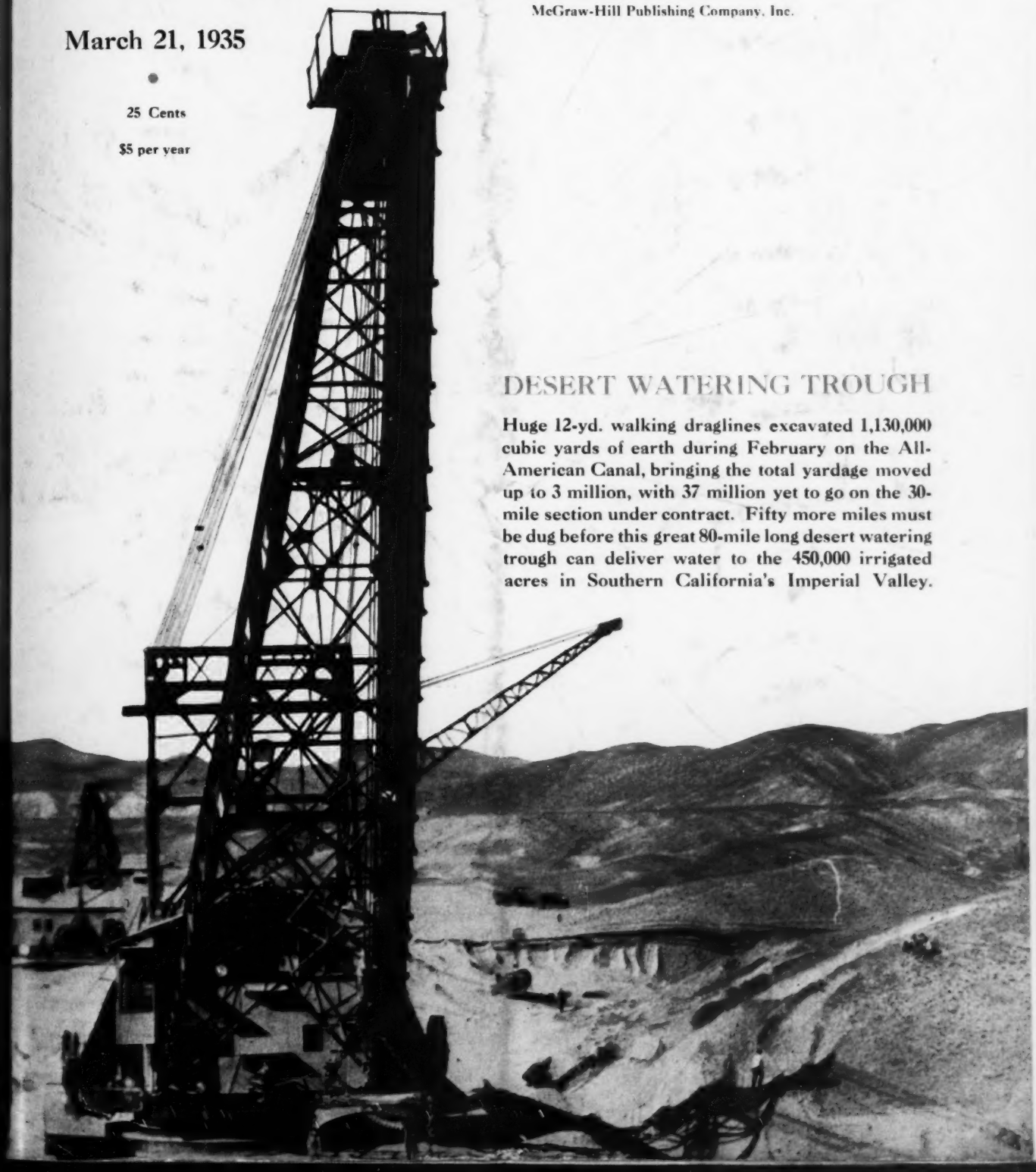
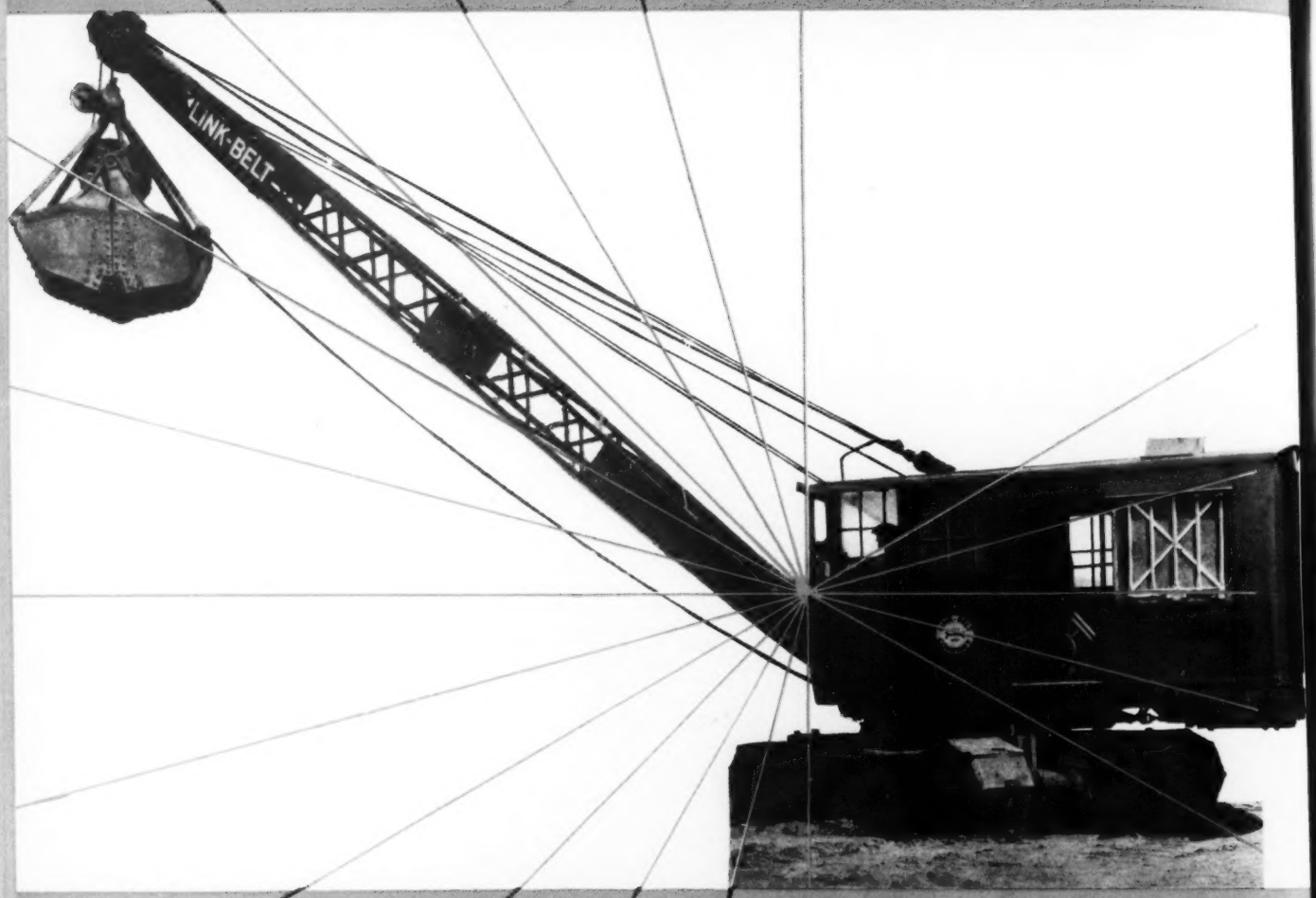


DESERT WATERING TROUGH

Huge 12-yd. walking draglines excavated 1,130,000 cubic yards of earth during February on the All-American Canal, bringing the total yardage moved up to 3 million, with 37 million yet to go on the 30-mile section under contract. Fifty more miles must be dug before this great 80-mile long desert watering trough can deliver water to the 450,000 irrigated acres in Southern California's Imperial Valley.

LINK-BELT COMPANY SOLD BY THE SHOW-DOWN



Link-Belt Crawler Crane equipped with "Caterpillar" Diesel 1100 Engine.

For its shovels and draglines, the Link-Belt Company requires power to match the performance and reputation of its products. In a SHOW-DOWN, the "Caterpillar" Diesel Engine proved rugged and reliable with unusually low costs for operation and maintenance—so Link-Belt adopted "Caterpillar" Diesels. Other manufacturers are following suit—let us show you why. Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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DIESEL

"Buy at Home" *Means* "Sell at Home"

UNDER the pressure of emergency we have turned to many dubious expedients. Some of them may have been justified by the stark need for immediate relief. Others may be compromises between honestly conflicting schools of thought. Still others, however, are so palpably futile that they can be explained on no reasonable grounds.

One of these last is the notion that each village, town, city or state should set up within itself a closed economy. The popular slogan to express this principle is "Buy at Home." In some states it is embodied in legislation providing that certain materials used on public works must be produced within the state or, in some cases, that preferential prices on such materials be paid to producers located within the state.

Whatever may be the form through which it is applied, such a practice has nothing to commend it, either on an emergency or long-term basis. It transgresses a basic principle of modern industrial economy, especially as this has been developed in the United States. It tends to cancel a most valuable national advantage and ignores the constitutional provisions set up to prevent just such economic partition of the nation.

ONE OF THE basic conditions that have done most to foster the remarkable progress of our country is its economic unity. That which has made possible the development of agriculture, industry and commerce on so vast and efficient a scale is our opportunity to administer as one economic unit so large an area, so generous a store of natural wealth and so diversified a population. Because of this, the fruit-grower of California, Texas or Florida is able to supply the breakfast tables of a nation, while the steel-maker of Birmingham, Pittsburgh or Gary can organize the production of steel to meet the needs of that nation.

The manufacturers of Detroit can develop amazing proficiency in the production of automobiles because they can ship them to Oregon, New York and St. Louis in exchange for timber, clothing and shoes. In short, every producer in the land knows that, directly or indirectly, his potential market is the 123,000,000 people of the United States. It is this situation, so different from that of Europe, which has made it possible for us to develop the extraordinary productivity of our people.

In considering this "Buy at Home" policy, we never should forget that its corollary must be "Sell at Home." So if it were possible to carry it to its logical conclusion each community would have to sell all its products to its own people and we should have a complete breakdown of the economic structure. The fact that we could not possibly carry such a policy to absurdity does not lessen the evil that results from following it even on a limited scale.

FAILURE to recognize all this was largely responsible for the collapse of our first effort to establish a nation under the Articles of Confederation. The new Constitution, therefore, was written to correct this vital defect. So now the Supreme Court, deciding a case that involves interference by a state with the flow of interstate commerce, points out that the Constitution forbids any state to neutralize the economic consequences of free trading among the states.

Especially pointed, in view of the price differentials set up by some states, is the court's ruling that this includes action by states that might prejudice commerce between states with different price levels. The court recalled that the commerce clauses of the Constitution were written because of "the mutual jealousies and aggressions of the states, taking form in customs' barriers and other economic retaliation."

ALTHOUGH the present case deals with the importation into a state of a commodity at a lower price than that imposed upon producers within the state, the reasoning applies with equal force to any attempt by a state or other political subdivision to interfere with free trade between the states.

When they wrote this provision, the founders knew from recent and vivid experience what they were about. The Supreme Court by its unanimous decision in this case shows how keenly it is aware of their intent. It should be manifest to all that short-sighted and provincial policies which contravene so basic a principle not only get us nowhere in an economic sense; they are in plain violation of the fundamental law.

Willard Chevalier

ENGINEERING NEWS-RECORD

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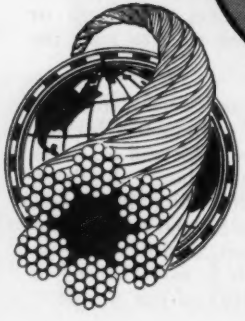

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In the News:

MORE LIVING UNITS will be built during 1935 through the PWA slum-clearance and low-cost housing program than were constructed by all private agencies in the 364 principal cities of the country in 1932 or 1933, according to an announcement by Director Hackett.

WITH THE DEFEAT of the McCarran prevailing-wage amendment of the $4,800,000,000 work-relief bill, the biggest hurdle is passed, and early enactment is being predicted.

SPRING THAWS AND STORMS in a half-dozen states of the Mississippi Valley have resulted in seasonal floods, which have inundated several areas in Illinois, Missouri and Mississippi.

ATTRACTION of heavy power-consuming industries to the region near the Bonneville Dam development on the Columbia River, near Portland, Ore., is the best procedure in providing the necessary increase in load capacity, according to a majority report of a state commission. A minority report favors a state-wide distribution network for wider use of electricity in homes, farms and light industries.

VISIBLE EVIDENCE of cable-stringing operations on the Triborough suspension bridge at New York was produced on March 18 with the raising of the south footwalk cables, to span the 1,380-ft. opening over the Hell Gate section of the East River.

CALLS FOR BIDS on the all-federal housing projects at Cleveland, Ohio, and Montgomery, Ala., and announcement that a contract will soon be let on the University project at Atlanta herald a substantial start on PWA operations. The Techwood project at Atlanta is under construction.

In This Issue:

AN INTERESTING SEAWALL of precast concrete sheetpiles backed up by composite brace piles has been built in Venezuela to protect oil fields from threatened flooding by Lake Maracaibo. Special driving rigs permit rapid construction.

WHAT PARTS of total construction costs are spent for labor, for materials and for overhead? Repeated requests for an answer to the question are met by a tabulation prepared by *Engineering News-Record* from figures collected in the 1929 construction census. It covers eighteen classes of work and includes subcontractor costs on building work.

A DISCUSSION of existing knowledge and past research on the function and action of reinforcing steel in concrete columns is presented by Commander Ben Moreell, U. S. Navy, and is related to the recent proposal for a column of plain concrete to be encased in a steel shell.

JOHN F. STEVENS in the first article of the series on "An Engineer's Recollections" recounts the experiences of a young engineer in the early days of building the Canadian Pacific Railway across the Plains. He also reveals how James J. Hill's strategy cut the cost of construction.

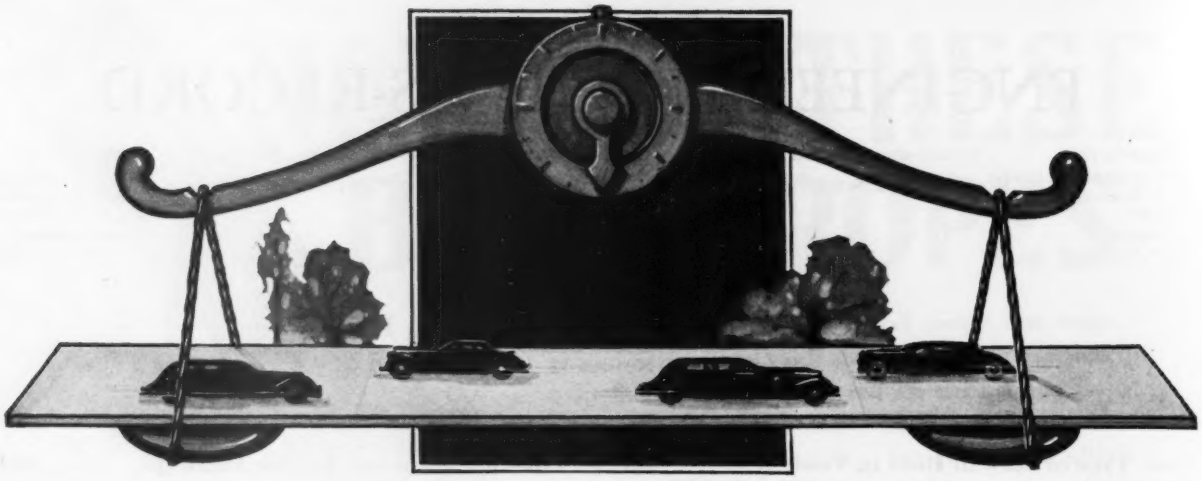
ONE OF THE PREMIER building-modernization jobs in the country occurred on a large department store in Los Angeles. Not only was the structure entirely changed and greatly improved in appearance, but its earthquake resistance was increased.

PNEUMATIC-CAISSON PRACTICE in Soviet Russia is described by the chief engineer of railroad bridge construction. Two novel expedients are described: the use of wood in place of steel as concrete reinforcing and the building of artificial islands that are merely mounds of dredged material protected from scour by a pile wall on the upstream side only.

MORE THAN 900 RAILROAD ENGINEERS assembled in Chicago last week for the annual meeting of the American Railway Engineering Association and for the "Railway Show" of the National Railway Appliances Association, the latter revived after a lapse of four years. The A.R.E.A. program covered all the major fields of the association and brought forth extensive discussion of several controversial subjects.

This Week's Cover:

MORE THAN 3,000,000 CU.YD. has been excavated on the All-American Canal project, out of the 40,000,000 cu.yd. already under contract and the 70,000,000 cu.yd. for completion of this gigantic water-delivery undertaking that is to enlarge and improve the existing irrigation supply from the Colorado River to the Imperial Valley in southern California. The 80-mile main canal starts with a 15,000-sec.-ft. capacity and has a 160-ft. bottom width and a 20-ft. depth. Present contracts are with W. E. Callahan, H. Gunther and J. P. Shirley ($4,859,587) for 39,389,000 cu.yd. of common excavation, and to John Griffith Co. ($226,800) for rock work. The Bureau of Reclamation has force-account operations under way, primarily as an unemployment-relief measure, and the work is described in an article in this issue.



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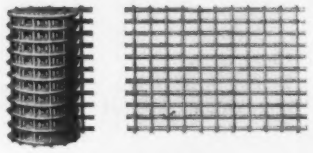

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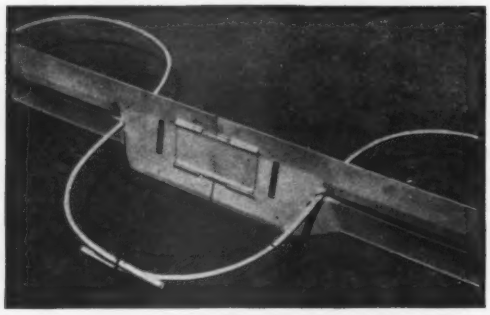

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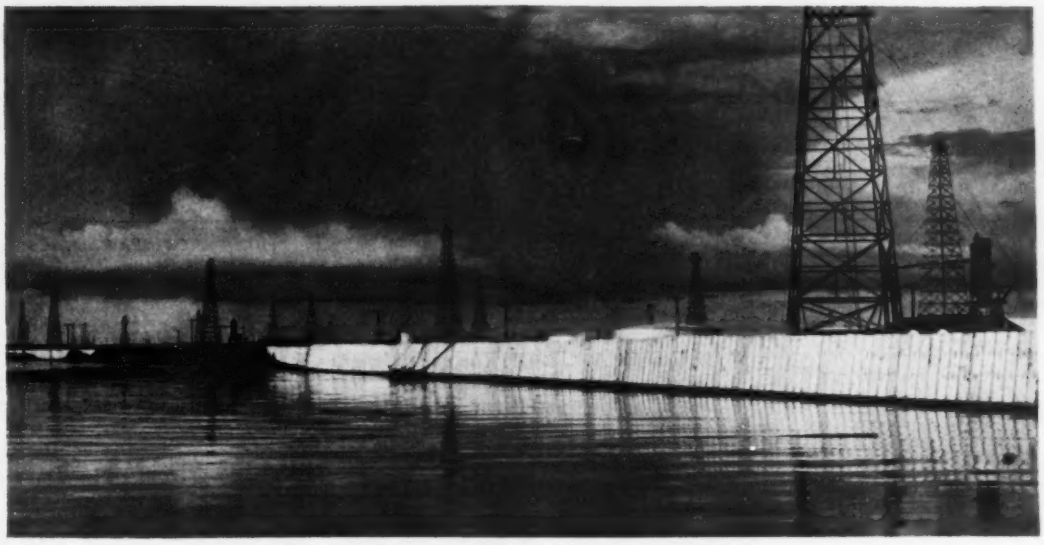


FIG. 1—PRECAST CONCRETE SHEETPILE SEAWALL protects oil-field at Lagunillas, Venezuela, from threatened flooding by Lake Maracaibo when shoreline settles. The oil blackened waters soon discolor the concrete, as can be seen in the background.

New Type Seawall Built for Subsiding Lake Shore in Venezuela

Wall of precast concrete sheetpiles backed up by composite brace piles protects oil fields on east shore of Lake Maracaibo from threatened engulfment—Barge-casting yard and special driving rigs permit fast work—Joints grouted after driving

By J. J. Collins
Project Manager, Raymond Concrete Pile Co., New York, N. Y.

A PECULIAR subsidence of ground on the eastern shore of lake Maracaibo at Lagunillas, Venezuela, required remedial measures to protect an adjacent extensive oil field development from flooding. Previous attempts at protection by steel sheetpiling and concrete-faced earth dikes proved only partly successful. A final solution was reached by building a continuous wall of reinforced-concrete sheetpiles,14,731 ft. long, rendered water tight by cement grouting under pressure, tied together by a heavily reinforced stringer beam and supported by inclined composite concrete and wood anchor piles. The wall is designed for a head of water level with the top.

The land adjacent to the village of Lagunillas, located on the lake shore, was originally mostly swamps and marshes, In 1923 a drainage program was started coincident with development of oil-fields both in the lake and on the shore. The Venezuelan Oil Concessions, Ltd., operate on land, while two other companies are active in drilling the lake bed.

Several years after the start of the drainage program it was observed that the ground was gradually subsiding. This subsidence was proceeding at an approximate rate of 12 in. annually and extended over a large part of the area occupied by the terminals of the oil companies. The settlement was vertical only, without any horizontal movement.

As the settlement increased along the lake shore, flooding of the land oil-fields and also extensive tank farms became imminent. Early attempts at protection included both steel sheetpile bulkheads and concrete-faced earth dikes. The former proved undesirable because of a peculiar corrosive effect of the lake waters (the lake is a tidal estuary), while the earth dikes, founded on swampy soil, repeatedly failed under overtopping in violent storms that occur periodically in this region.

The concrete sheetpile design was finally chosen because it was possible to get a watertight wall, resistant to corrosive lake waters and, secondly, this design provided a flexible wall that would settle with the ground, without deteriorating or losing its watertight properties. The top elevation of the wall was determined, for the most part, by

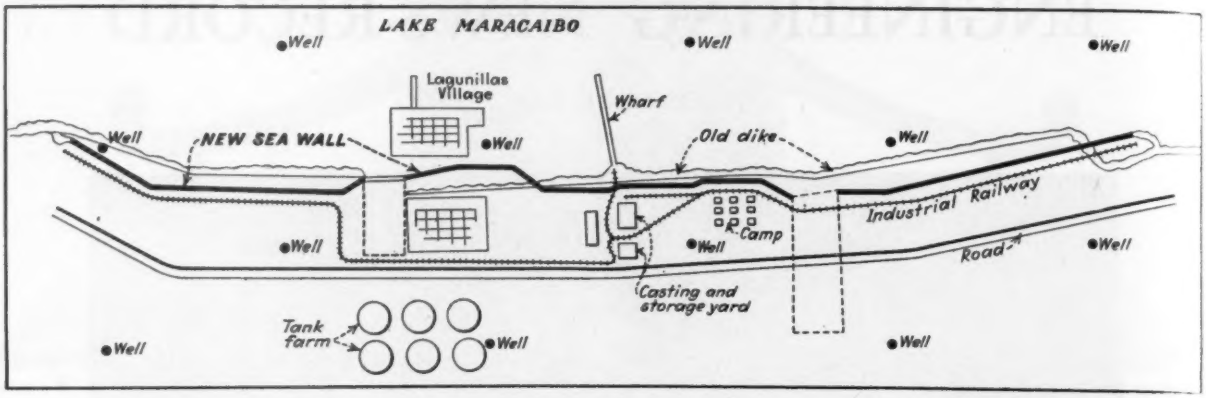


FIG. 3—NEW SEAWALL cuts back and forth across the old levee protections and splits in two the Lagunillas village of buildings on stilts.

FIG. 2—LOCATION of the seawall at Lagunillas, on the east shore of Lake Maracaibo, Venezuela.

the inverse subsidence curves. These curves, plotted by the oil company's engineers and compiled from records of settlement, showed the rate of subsidence at all points along the wall. Where the subsidence rate was the highest the top of the wall was made correspondingly high.

Design of wall

The wall is made up of 11½x24-in. reinforced-concrete sheetpiles, tied together with a 24x27-in. concrete back beam and braced by inclined composite piles set at 7½-ft. intervals (Fig. 5). The sheetpiles were cast with a V-shaped tongue and grooved joint, with a diamond-shaped recess left at the center of the joint for grouting. The average length of sheetpile is 31 ft. To prevent scour at the base of the wall and to assist in breaking the force of waves, the sheetpiles were driven on a 1:8 batter, the top leaning landward. All piles were driven into an impervious clay.

Special angle piles were designed for changes in alignment, each special unit diverging 7½ deg. Other specials were required for straightening the alignment and for correcting the batter of the face. Expansion piles were used at regular intervals, being designed as solid units below ground level and as split units sealed with a ½-in. joint filler above ground; the split units have slip joints.

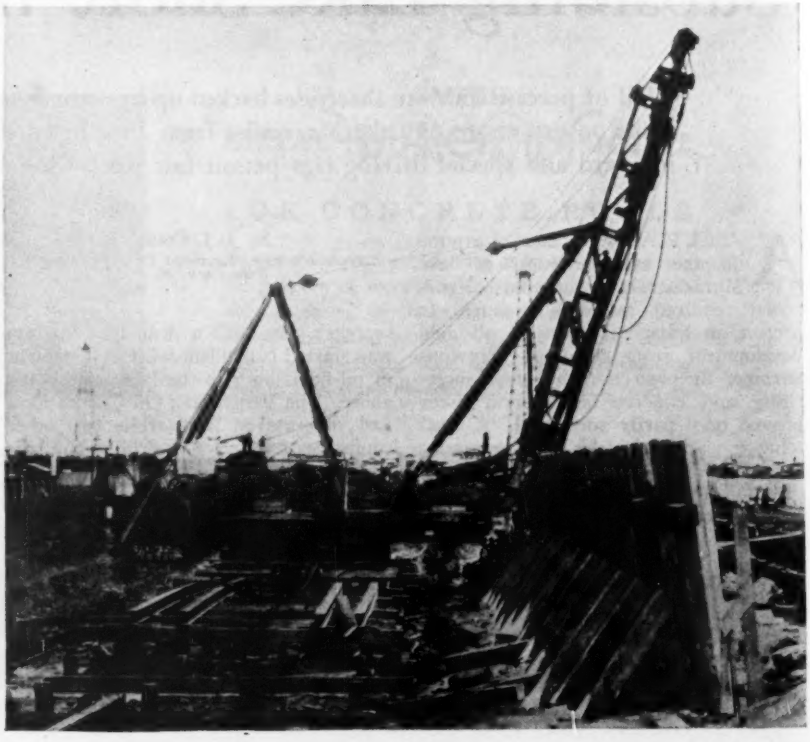
The composite brace piles consisted of a wood pile 50 to 60 ft. long connected to a 12x12-in. concrete top section 24 ft. long by means of a 12-in. extra-heavy pipe sleeve 4 ft. long. The entire length of wood pile, including the joint, was driven below permanent water level. These brace piles were designed to support a load of 25 tons.

The back beam was poured in place, to connect the brace and sheetpile units, the beam being divided into 150-ft. expansion lengths. In casting the sheetpiles, tierods hooked around the reinforcing bars were left extending from the back side. These rods, along with extensions of reinforcing of the top section of the composite piles, were tied into the reinforcing of the back beam.

Speed in construction was one of the requirements of the contract. The contract was awarded on April 23, 1932. On April 29 the first shipment of materials and equipment was forwarded from New York. The first pile was cast on May 29, and driving started June 4 with two driving rigs. By Aug. 1 two more drivers were in service driving sheet and batter piles. By Nov. 1 the four rigs were placing 1,000 lin.-ft. of wall per week. The entire length of 14,731 ft. was completed on Jan. 23, 1933, a month ahead of stipulated completion date.

A casting yard to accommodate 116 pile forms on a 66x319-ft. platform was established at the shore end of the oil company's loading pier. This site was

FIG. 4—PILEDRIVER RIG in action. Of the revolving type moved on rollers, it was designed to drive both sheet and brace piles.



ideal for the unloading of sand and stone from barge to land storage as well as for the unloading of materials and equipment shipped from foreign ports. A 1-yd. steam mixer with a batching hopper charged by a stiff-leg derrick furnished all concrete for the precast units. Piles were handled from forms to storage and to transporting cars by a three-track gantry crane. The storage yard was laid out with a capacity of 1,800 piles. In storage the piles rested on a sand bed and were kept throughly wet to prevent cracking in the high temperatures.

Particular care was required in setting up the side forms in the casting yard, for the hot sun and wetting from concrete-pouring operations tended to crack and warp the green lumber. Reinforcing steel was made up in cages on racks alongside a narrow-gage track, and was moved from the racks to within reach of the gantry on small cars.

Concrete was a 1:2:4 mix and was handled from the central plant to the casting platform in 1-yd. push cars, where it was transferred to buggies for final disposition in the forms. Internal electric vibrators consolidated the mix in the forms. Their use, coupled with a low water-cement ratio and the use of extra cement, resulted in a concrete of 3,000-lb. strength in seven days when required. Piles were removed from the forms after 48 hours and could be driven in four to six days after casting without damage. A 24-in.-gage track built along the line of the new wall permitted delivery of piles from storage to drivers on flat cars.

Piledriving

Four special whirley rigs were used in driving the piles. These rigs consisted of a 24-ft. bedsill and turntable, and a four-drum steam engine. The leads, boom and spotter were of special design, to permit the instant change of position required for driving sheetpiles on the inclined braces, which were driven along with the sheets by the same rig (Fig. 4). Steam for both the hammers and engines was supplied from fixed oil-field boilers. The rigs were moved on rollers traveling on longitudinal H-beam runners 44 ft. long. Four 24-ft. wood caps supported each length of runner beams. These caps were blocked up on cribbing or on mats as the ground conditions warranted. Where the alignment left the shore and went into the lake, pile trestles were built to carry the drivers. These trestles were driven in advance by a skid driver. At one point a steel sheetpile cofferdam was required to protect an existing levee.

To secure proper alignment of the sheetpiles, a temporary wood-framing system was used, made up of 10x10-in. top and bottom wales with 6x6-in. post supports and 2x12-in. spreaders (Fig. 6). Two bolt holes were cast in each sheetpile, through which the wales were bolted as the piles were driven, holding the sheets in proper alignment. The top wale was left in place until the back beam was cast, while the lower wale and the rest of the framing were moved ahead continuously. Along with the sheetpile temporary framing was placed a wood rail carried on stakes, set at the proper alignment and elevation to serve as a guide for driving the brace piles.

At first, considerable difficulty was experienced in placing the sheetpiles, as they had a tendency to kick out of line, and sand wedged in between the joints, separating the adjoining units. These difficulties were overcome by careful jetting immediately in advance of driving. The ground, for the most part, was a silty sand. A 2½-in. jet readily washed out a hole large enough to drop the sheet very near to final location. Speed was essential in getting each pile lined up on correct batter and tight against the previously driven pile before driving, to prevent sand from wedging into the joint.

A 7-S portable mixer provided concrete for the back beam. From the mixer a long ramp was built to a working platform carried on the brace piles. Concreting was continuous for each 150-ft. length between expansion joints. One crew using a set of 300 ft. of bottom forms and 150 ft. of side forms was continually kept busy erecting behind each driver. The freshly poured beam was kept wet for four days, with a long perforated pipe continuously spraying over it.

Grouting the joints

Grouting of the joints between sheetpiles was an important operation to secure a watertight wall. After many and

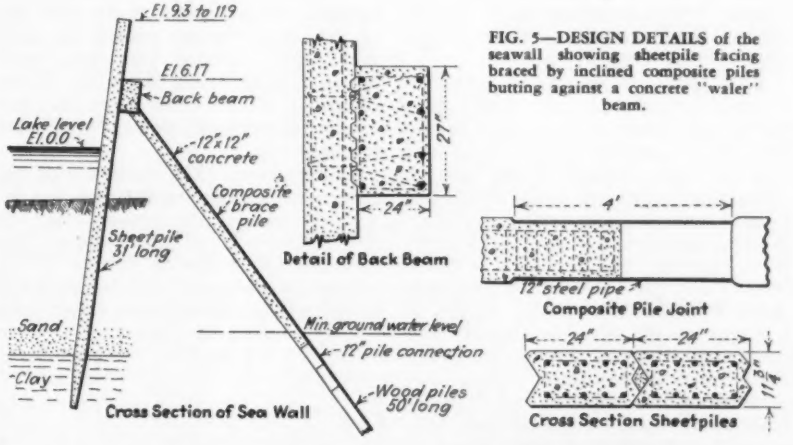


FIG. 5—DESIGN DETAILS of the seawall showing sheetpile facing braced by inclined composite piles butting against a concrete "waler" beam.

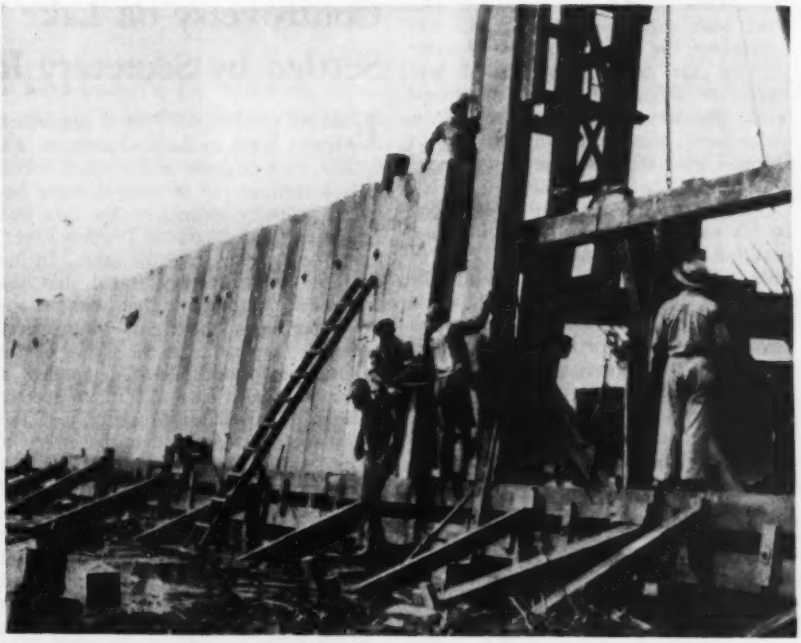


FIG. 6—TIMBER GUIDE FRAME erected in advance of driving served to keep the sheetpiles in alignment while being driven. The top wale on the back side was left bolted in place until after the longitudinal concrete beam had been cast.

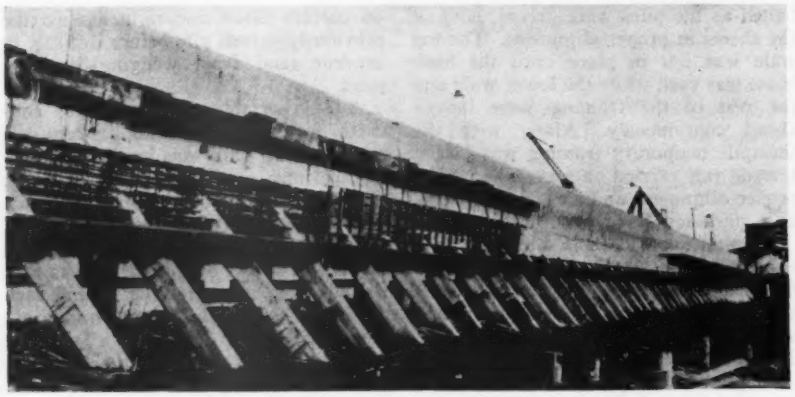


FIG. 7—THE CONCRETE BEAM tying the sheet and brace piles together was cast in place immediately behind the piledriving operations. A working platform was built on the inclined brace piles.

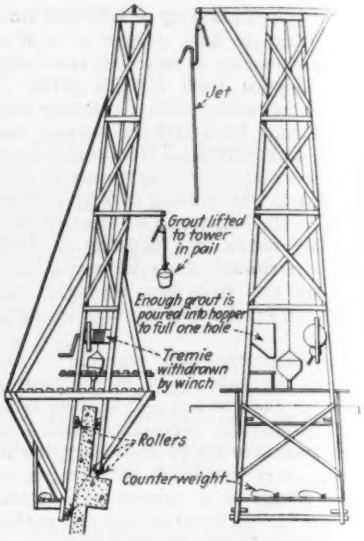


FIG. 8—GROUTING TOWER devised to travel along the wall and carry equipment for filling the vertical joints between the sheetpiles.

varied experiments the tremie method was selected as best for placing the grout in the joint recesses. For this purpose a light traveling tower was designed, large enough to accommodate six workmen (Fig. 8).

First, the joint was flushed out with a water jet, the jet pipe being long enough to reach to the bottom of the hole. Water, obtained from an oil-field pipe line, was delivered to the jet at a pressure varying from 160 to 200 lb. per sq.in. Grout, of 1 part cement to 2 parts of sand, mixed to a sloppy consistency, was made on the ground in a small mixer. The exact amount of grout required to fill a hole was then hoisted to a hopper on the tower in buckets. The grout was lowered through a tremie made up of a sheet-metal hopper connected to a 2-in. pipe, the whole being attached to small cables leading to a hoist. The tremie pipe was lowered to the bottom of the hole before it was filled with grout. As the tremie was withdrawn, the hole was filled and water left by the flushing operations was forced out through the joint at ground level. The tremie was used only to the water level; above this point grout was dropped from the tower hopper into the joint hole.

Special covers of burlap-wrapped boards were placed over the joints when grouting sections in the lake. The lower ends of these covers were driven into the lake bed, tight against the wall, while the upper ends were clamped through the bolt holes used for holding the alignment wales. Wherever possible the wall was tested for watertightness by breaking the levee in front and letting the lake waters surge against the face. The wall was found to be absolutely watertight at all points.

Native stone used

Stone for all concrete work was quarried and crushed at a plant on Toas Island, 75 miles away. The rock was a pure limestone, with a considerable loss from dusting during crushing operations, this loss averaging 40 per cent. The job required 100 cu.yd. of stone per day, which was towed in barges direct from the plant to the storage yard at the casting yard. Sand came from the beach at Punta Palmas, at the north end of the lake. Natives loaded the sand with 5-gal. gasoline cans into small barges holding about 65 cu.yd. A tow composed of one stone barge and two sand barges required almost 24 hours for a round trip.

In September, 1933, the new wall was shaken by a slight earthquake, but inspection revealed no damage done and the development of no leakage. Ten months after completion another careful inspection was made and the wall was found to be in perfect shape, despite subsidence of land of more than 1 ft. in places and the weathering of two severe storms.

The wall was built for the Venezuelan Oil Concessions, Ltd., under the direction of H.G.A. Quarles van Ufford and L. W. Korthals of that company. It was designed and constructed by the Raymond Concrete Pile Co., New York, with the author as project manager and R. E. Colvin as superintendent in charge.

Controversy on Lake Tahoe Level Settled by Secretary Ickes

ESTABLISHMENT of a maximum water level in Lake Tahoe, at El. 6,229.1, by a decision of Secretary Ickes, ends a controversy of several years between property owners on the lake and irrigation interests on the Truckee River, the outlet stream from the lake. In his decision the Secretary stated that the lake level cannot go higher without encroaching upon the rights of property owners. Opponents to the fixing of the adopted maximum level demanded a water surface at El. 6,228 ft., to protect owners of lakeshore property, but the Secretary pointed out that the effect of adopting this lower figure during the low-water years of 1915 and 1924 would have resulted in a loss of 500,000 acre-ft. of lake storage to the irrigated land in Nevada. This amount of water could not have been stored in the proposed Upper Truckee Reservoir, even though this reservoir had filled during those seasons. During the years 1924 and 1934, because of the serious deficiency in precipitation, the level of Lake Tahoe did not at any time rise to the 6,228-ft. elevation.

Further, Mr. Ickes stated that settlers along the Truckee River have established homes, in good faith, on land that cannot be expected to produce crops without the flow of water from the lake, and that these settlers have acquired rights which cannot be ignored. Some of the landowners around the lake, which is extensively used for summer resort and recreational purposes, had objected to the high-water level, contending that it would adversely affect the scenic attractions, but the Secretary pointed out that since 1906 the lake level has ranged between El. 6,231 and 6,233, without causing any serious damage to the recreational development. The need for the additional 1.1 ft. of storage on the lake for the use of irrigation was the deciding factor in the case.

The decision, as it affects the Department of the Interior, ratifies the Truckee River agreement on the Newlands reclamation project.

Distribution of Construction Costs on Contract Work

BECAUSE of repeated requests for information concerning the breakdown of material, labor and overhead costs on construction work, the following two tables have been compiled from data collected for the 1930 construction census by the Bureau of the Census. The census was based on contract operations only and was confined to the year 1929. Information was gathered from 26,671 contracting firms who performed work aggregating $5,550,000,000 that year. Though the period in which the data were collected is now more than five years past, the distribution percentages should still be applicable.

For all classes of construction, 43.8 per cent of the total contract cost is for material, 30.7 per cent for labor wages, 7.4 per cent for salaries of executive and supervisory forces, 10.6 per cent for general overhead and plant charges, and the remaining 7.5 per cent is classed as undistributed expense and profit. Table I shows this breakdown, as well as corresponding breakdowns for three classes of contractors—operative builders, general contractors and subcontractors. The table also reveals that, on the average, 23.7 per cent of construction work of all classes is let to subcontractors.

Table I also shows the breakdown of material and labor costs in all building construction and in several types of buildings. Material costs are highest, in per centage, in industrial and manufacturing buildings because this type of building is simple to construct with less labor required. The commercial or office type of building has the greatest ratio of labor costs of any class of buildings—32.2 per cent.

The same breakdown of material, labor and overhead costs is carried through various classes of heavy construction. Naturally, grading work shows the lowest ratio of material costs, while bridges, waterworks and power plants show the highest. The ratio of overhead costs, including plant charges, is 10.6 per cent for all construction, but jumps to more than 30 per cent on grading, dredging and levee work. The balance of costs, other than materials, labor, salaries and overhead, which includes profits, is highest on subway construction, almost twice that of the general average of 7.5 per cent.

A separate breakdown of building costs divided into various trades classi-

TABLE I—DISTRIBUTION OF CONSTRUCTION COSTS
In Percentages of Total Cost

Item	Classes of Contractors				Building Const.					Heavy Construction Classifications															
	All Classes	Operative Builders	General Contractors	Subcontractors	All Building Const.	Bldg.—Not Specialized	Bldg.—Commercial	Bldg.—Mfg. & Ind.	Bldg.—Residential	Highways	Bridges	Grading	Street Paving	Sewer & Water Lines	Dams & Reservoirs	Waterworks	Dredging	Levees	Railroads	Foundations	Power Plants	Air Transport	Refuse Disposal	Oil & Gas Lines	Subways	Telephone & Misc.
1. Materials—Gen. Contr.	33.0	13.8	28.2	45.0	24.8	24.5	18.3	36.8	26.2	38.0	39.9	8.3	38.6	35.4	28.8	40.6	22.0	12.5	24.5	31.1	34.8	25.3	25.0	30.6	28.8	29.0
—Subcontr.	10.8	29.8	13.8	1.5	18.9	18.8	22.9	15.1	19.0	3.8	3.1	0.5	3.7	1.8	3.4	2.9	2.9	3.9	3.8	4.2	15.3	5.9	5.8	6.9	3.7	1.2
Total Materials	**43.8**	**43.6**	**42.0**	**46.5**	**43.7**	**43.3**	**41.2**	**51.9**	**45.2**	**41.8**	**43.0**	**8.8**	**42.3**	**37.2**	**32.2**	**43.5**	**24.9**	**16.4**	**28.3**	**35.3**	**50.1**	**31.2**	**30.8**	**37.5**	**32.5**	**30.2**
2. Labor—Gen. Contr.	23.6	8.3	21.6	28.9	19.3	19.9	17.5	13.0	16.8	23.0	26.4	36.4	21.7	31.6	30.3	26.2	27.6	28.1	32.9	31.1	23.9	35.4	31.2	28.0	32.3	32.7
—Subcontr.	7.1	19.2	8.9	1.0	12.2	12.1	14.7	9.8	12.2	2.7	3.4	2.9	3.0	1.9	1.7	1.5	2.2	4.4	4.3	4.7	5.3	3.6	3.7	2.8	2.4	0.3
Total Labor	**30.7**	**27.5**	**30.5**	**29.9**	**31.5**	**32.0**	**32.2**	**22.8**	**29.0**	**25.7**	**29.8**	**39.3**	**24.7**	**33.5**	**32.0**	**27.7**	**29.8**	**32.5**	**37.2**	**35.8**	**29.2**	**39.0**	**34.9**	**30.8**	**34.7**	**33.0**
3. Salaries—Gen. Contr.	5.6	2.8	5.0	7.2	4.5	4.6	4.2	4.7	3.9	5.2	5.4	7.0	5.6	6.1	6.3	6.9	6.3	10.3	5.8	8.1	6.4	10.1	6.2	4.3	5.7	7.3
—Subcontr.	1.8	4.8	2.2	0.2	3.0	3.0	3.6	2.4	3.0	0.9	0.6	0.7	0.7	0.2	1.0	0.9	0.8	0.7	0.7	0.8	0.9	0.9	0.9	0.4	0.6	0.3
Total Salaries	**7.4**	**7.6**	**7.2**	**7.4**	**7.5**	**7.6**	**7.8**	**7.1**	**6.9**	**6.1**	**6.0**	**7.7**	**6.3**	**6.3**	**7.3**	**7.8**	**7.1**	**11.0**	**6.5**	**8.9**	**7.3**	**11.0**	**7.1**	**4.7**	**6.3**	**7.6**
4. Misc. overhead: Equip. rental—Gen. Contr.	0.4	....	0.5	0.3	0.1	0.2	0.2	0.2	....	1.4	0.4	2.7	1.4	1.1	0.6	0.6	1.2	3.1	1.2	0.7	0.2	2.0	....	0.1	0.5	2.7
—Subcontr.	0.1	0.2	0.1	....	0.1	0.1	0.1	0.1	0.1	....	0.1	0.9	0.1	....	....	....	....	....	....	....	....	....	....	....	....	....
Plant charges, rent, interest, bonds, insurance, etc.—Gen. Contr.	8.0	5.2	7.7	8.8	4.0	3.9	4.3	4.2	4.1	15.1	11.8	26.6	13.9	12.8	14.6	12.6	27.8	25.9	14.7	11.0	5.5	12.6	14.9	16.0	11.4	13.8
—Subcontr.	2.1	5.6	2.6	0.3	3.6	3.5	4.3	2.8	3.6	1.1	1.4	2.4	1.3	0.4	0.3	0.3	1.4	1.7	1.7	1.9	1.3	1.1	1.1	1.3	0.7	0.3
Total overhead	**10.6**	**11.0**	**10.9**	**9.4**	**7.8**	**7.7**	**8.9**	**7.3**	**7.8**	**17.2**	**13.7**	**32.6**	**16.7**	**14.3**	**15.5**	**13.5**	**30.4**	**30.7**	**17.6**	**13.8**	**7.0**	**15.7**	**16.0**	**17.4**	**12.6**	**16.8**
Total Items 1 to 4	92.5	89.7	90.6	93.2	90.5	90.6	90.1	89.1	88.9	90.8	92.5	88.4	90.0	91.3	87.0	92.5	92.2	90.6	89.6	93.6	93.6	96.9	88.8	90.4	86.1	87.6
5. Balance of charges, incl. undistributed expense and profits—Gen. Contr.	5.7	2.1	5.6	6.4	4.3	4.1	3.5	6.5	5.8	7.2	6.9	10.4	9.2	7.8	11.6	6.4	7.0	7.6	8.6	5.5	5.5	2.0	10.2	9.0	13.4	11.4
—Subcontr.	1.8	8.2	3.8	0.4	5.2	5.3	6.4	4.4	5.3	2.0	0.6	1.2	0.8	0.9	1.4	1.1	0.8	1.8	1.8	0.9	0.9	1.1	1.0	0.6	0.5	1.0
Total Balance	**7.5**	**10.3**	**9.4**	**6.8**	**9.5**	**9.4**	**9.9**	**10.9**	**11.1**	**9.2**	**7.5**	**11.6**	**10.0**	**8.7**	**13.0**	**7.5**	**7.8**	**9.4**	**10.4**	**6.4**	**6.4**	**3.1**	**11.2**	**9.6**	**13.9**	**12.4**
Total all items	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Percentage of work sublet	23.7	67.8	31.4	3.4	43.0	42.8	52.0	34.4	43.2	10.0	9.2	8.6	9.6	5.2	7.8	6.7	8.1	12.5	12.3	13.5	23.7	12.6	12.5	12.0	7.9	3.1

TABLE II—DISTRIBUTION OF SUBCONTRACTORS' EXPENSES ON BUILDING WORK
In percentages of total value of subcontracting work

Class of Subcontractor	Work Sublet	Materials	Wages	Salaries	Equip. Rental	Bonds, Insurance, Plant Charges, Rent, etc.	Undistributed Balance Incl. Profits
Carpentry and wood floors	7.5	40.5	30.0	7.8	0.6	7.2	6.4
Concrete	3.9	34.8	36.3	8.0	0.7	9.0	7.3
Electrical	0.8	44.0	31.2	9.1	0.2	8.6	6.1
Elevators	2.2	65.7	16.8	2.9	0.1	3.3	9.0
Plumbing and heating	3.2	52.0	24.4	7.1	....	7.4	5.9
Masonry	3.2	40.1	38.6	5.6	0.5	6.3	5.7
Painting and decorating	1.0	20.6	52.0	9.2	0.1	9.0	8.1
Glass and glazing	2.2	52.0	18.4	8.5	0.1	11.8	7.0
Lath and plaster	5.8	26.0	51.0	6.2	0.3	4.8	5.9
Roofing and sheet metal	1.6	44.0	25.6	9.9	0.1	12.4	6.4
Steel erection	8.5	50.7	19.3	5.0	0.2	9.5	6.8
Stonework	4.9	36.8	32.8	8.2	0.4	9.9	7.0
Marble and tile	1.2	44.5	30.4	7.2	0.1	9.2	7.4
Wrecking	1.7	1.0	53.3	13.3	3.0	20.0	7.7
Excavating	6.5	6.2	35.8	8.2	6.2	27.8	9.3
Ornamental iron	3.8	48.3	18.6	7.6	.....	10.4	11.3
Soundproofing	1.6	52.5	18.4	7.3	.....	9.1	10.1
Flooring	1.1	47.3	26.4	7.4	.....	12.1	5.7

fications is given in Table II. The materials ratio is highest on elevator construction (65.7 per cent) and is lowest on wrecking (1 per cent). The wage ratio is highest on painting and decorating and on wrecking classifications. General overhead varies from 3.3 per cent on elevators to 27.8 per cent on excavating. Table II also carries a column showing the percentage of work sublet by subcontractors, which amounts to as high as 8.5 per cent in steel erection. The percentages in this column have not been broken down into labor, material and other costs.

The Place and Function of Steel in Concrete Columns

A discussion of existing knowledge and past research prompted by the recent proposal for a column of plain concrete to be encased in a steel shell

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THE PROPOSAL to build concrete columns without rod reinforcement but instead to encase them in a steel-plate shell, relieved by various expedients of taking any compression from vertical loads, was made recently in these pages. In effect, such a steel encasement is merely a continuous spiral, and various investigations (most recently those at Illinois and Lehigh universities) have demonstrated the importance of spirals in adding both toughness and strength to concrete columns. Yet there are other considerations such as the strengthening effect of vertical rod steel and the resistance it furnishes to deflection, both vertical and horizontal, which are ignored in the steel-encased column. The proposal raises the question of the function of steel reinforcing in concrete columns and the present state of our knowledge concerning it. Lieut.-Commander Moreell's discussion constitutes a helpful and authoritative contribution to the subject. It is to be noted that it represents his personal opinion only and is not to be construed as official or reflecting the views of the Navy Department. —EDITOR.

THE concrete columns composed of a plain concrete shaft encased in a steel shell as proposed by Prof. W. A. Lohr (*ENR*, Dec. 13, 1934, p. 760) and the conscientious study upon which the proposal was based serve a useful purpose by directing attention to an important subject now receiving the active attention of engineers interested in concrete design and construction. The following comments are submitted in the hope that they will contribute to a better understanding of the subject and are in no wise intended to detract in any degree from the work of Professor Lohr and his associates. Some of the considerations discussed may have escaped their attention, however, and may be helpful in arriving at conclusions leading to safe and economical designs.

Early studies of lateral restraint

A brief review of the history of laterally restrained concrete compression members may be of interest. The effect of lateral restraint on the compressive strength of concrete was first investigated about 1899 by Considère, eminent French scientist and engineer. Concrete cylinders, covered with a waterproof envelope, were subjected to lateral liquid pressures of variable intensities, and while in this state they were tested to destruction by compressive loads applied to the cylinder ends. As a result of these tests, Considère concluded that the ultimate strength of a concrete compression member could be expressed by the formula,

$$R = C + kP \qquad (1)$$

where R is the ultimate unit strength of the member when restrained by a lateral pressure P; C is the ultimate unit strength of the member if there were no lateral pressure; k is a constant depending upon the characteristics of the concrete; and P is the unit lateral pressure.

For the concrete used in his tests, he found a value of k equal to 4.8. For example, if to a concrete cylinder with an ultimate strength of 2,000 lb. per sq.in. when loaded axially a lateral pressure of 500 lb. per sq.in. is applied, the resistance to axial loading will be increased to 4,400 lb. per sq.in.

Considère's conclusions were later verified by Richart, Brandzaeg and Brown at the University of Illinois (Bulletin 185, November, 1928), who found a value for k of 4.1. The difference between this value and that of Considère can probably be attributed to differences in the composition of the concrete and in the test procedures.

These studies led Considère to an investigation of the best means of providing lateral restraint for concrete compression members. In a series of papers published from 1900 to 1903, he introduced to the engineering world what he called "béton fretté," or "hooped concrete," which is known to American engineers as spirally reinforced concrete. Considère stated that the function of the "frettes" or lateral reinforcement is to furnish the lateral pressure which, in the tests referred to above, was provided by the liquid. The lateral reinforcement is called into play by virtue of the lateral distention of the concrete when subjected to compressive force. He also tried other means of providing the lateral restraint, including separate bands and continuous metal tubes, but he concluded that the continuous spiral was the most efficient.

As a result of his studies, Considère concluded that the ultimate strength of a concrete column reinforced with spirals and vertical steel can be represented as the sum of the following three factors: (*a*) the ultimate strength of the concrete core; (*b*) the yield-point strength of the vertical steel; (*c*) the yield-point strength of the lateral steel with an effectiveness ratio of 2.4.

By "effectiveness ratio" is meant the ratio between the strength added to the concrete column by the lateral steel and that which would be added by the same volume of steel if it were used as vertical reinforcement.

In 1929 the American Concrete Institute sponsored the most comprehensive series of column tests which has ever been undertaken. These tests were performed at the University of Illinois and at Lehigh University and reported in the February, 1933, issue of the *Journal* of the American Concrete Institute and in *Engineering News-Record*, May 26, 1932, p. 764. The general conclusions confirmed those of Considère, except that the average value of the effectiveness ratio of lateral reinforcement was found to be 2.0.

The point which it is desired to bring out in the foregoing is that the utility of lateral reinforcement for increasing the compressive strength of concrete has been recognized for over 30 years and is not a new conception. As indicated by the above formula, the amount by which the ultimate strength of the concrete can be increased is dependent only upon the amount of lateral reinforcement which it is desired to use.

Spirals and tubes

Professor Lohr states that the essential difference between his column and the Lally column is the "attempt to relieve the encasing tube of longitudinal stress." He states, also, that the principal purpose of the steel casing is to oppose the increase in diameter of the concrete core. Laboratory tests and construction experience over a long period of years have indicated that the most desirable form of reinforcing which can be used to furnish lateral restraint is the continuous spiral, which is also obviously incapable of taking longitudinal stress. Some allowance for the increase in strength and ductility of a

column so reinforced is made in one way or another in all published codes and standard specifications. There is some disagreement as to the magnitude of this allowance and the method of applying it, but there is no disagreement as to the principal involved. It is well to point out that full advantage cannot be taken of the great increase in compressive strength provided by lateral reinforcement because of the excessive deflections required to bring the lateral reinforcement into play.

In view of the foregoing, the question arises whether consideration has ever before been given to the use of a continuous steel tube for lateral reinforcement, as proposed by Professor Lohr. In a paper published by Considère in 1902 he stated, "It would seem that, since the elastic efficiency of the hooping increases with the closeness of the hoops, at least within certain limits, the ideal will be reached by the use of continuous tubes; but such is not the case for several reasons. The external layer of concrete, which is necessary for the protection of the tube, will break off as do all covers applied to surfaces subject to high stresses. . . . The best type of hooping thus appears to be helicoidal spirals of suitable dimensions."

In his book "Reinforced Concrete," published in 1921, Mesnager, discussing Considère's tests, states: "If we admit that $R > C + 4P$, we find that a continuous metallic cylinder surrounding a concrete column and so arranged that it will not be subjected to vertical loads but only to horizontal pressures, has twice the effect of the same volume of reinforcement in the form of vertical bars. . . . In practical applications we replace the continuous tube by spirals so closely spaced that the strength of the concrete does not permit it to escape from between the spirals; some longitudinal reinforcement, which is always necessary for other reasons, contributes to the retention of the concrete. However, Rabut has used concrete in tubes which he called 'tubed concrete.'"

It is evident from the foregoing that the possibility of using continuous tubes which would not be subjected to vertical pressure was not overlooked and, in fact, it appears that such tubes have been used.

It can be easily demonstrated that the maximum possible effectiveness ratio obtainable by lateral reinforcement is 0.5 k. As pointed out above, Considère found a value of $k = 4.8$. In subsequent tests he found an effectiveness ratio of 2.4 for continuous spirals. At the University of Illinois the value of k was found to be 4.1, and later an average effectiveness ratio of 2.0 was found. It is evident, therefore, that properly designed spiral reinforcement will furnish the maximum lateral restraint that is possible for the amount of metal involved and, therefore, must of necessity be as efficient as the continuous tube in this respect.

The Lohr column therefore, does not differ in method of action or effectiveness from the well-known spirally reinforced column. The question, then, is whether the advantages of the continuous casing outweigh its disadvantages. Professor Lohr's column would require the use of a separate built-up fireproofing made of small blocks, not securely bonded to the main member. As stated by Considère and proved by tests on full-size members, if the working stress recommended by Professor Lohr is used, such fireproofing would almost surely crack and perhaps spall off when the column receives its full working load. Also, the laying up of these small blocks would be costly and the covering of doubtful durability in case of fire. In the spiral column the fireproofing is cast monolithically with the body of the column and is securely bonded thereto. Such fireproofing will separate only when the column reaches its yield point, well above the usually recommended working stress.

While it is true that the Lohr column uses the steel form as lateral reinforcement and thus saves the cost of dismounting the form, it should be noted that in modern construction practice the column forms are used over and over again. The cost of dismounting the form is a small price to pay for the improved fire protection and the economy of placing the fire protection in the same operation as the body of the column.

It should be noted, also, that within the range of usual working stresses the concrete outside of the spiral adds materially to the strength of the column, and, therefore, reduces the deflection under working loads. This is an important item.

It is pertinent to note that in the Lohr column the ability of the steel envelope to provide lateral restraint is dependent to a very large degree upon the absence of friction between the envelope and the concrete. If friction is present, the steel tube will take vertical load, which will result in lateral distention, thus reducing its restraining effect. There is, also, the danger of buckling of the thin shell resulting from high vertical stresses. Whether friction between the concrete and the envelope can be prevented under practical working conditions is doubtful. In the example given by Professor Lohr, he assumes a lateral pressure against the steel tube of 240 lb. per sq.in. under working loads. It is difficult to see how friction between two surfaces held together by a force of this magnitude can be avoided under field conditions.

Professor Lohr claims as an advantage that "A circular steel shell filled with concrete has great bending resistance," but later states that this question will be satisfactorily answered only by laboratory tests. If our theory of concrete design is reasonably correct, it would be possible for the encased column to develop appreciable elastic bending resistance only if there is bond between the steel and the concrete. But Professor Lohr deliberately destroys this bond. It is unquestionably true that the encased column would have some resistance to bending distortion, but in concrete structures elastic bending resistance to prevent large distortions is what is needed.

Purpose of vertical rods

In the foregoing, nothing has been said about the omission of vertical reinforcement from the Lohr column. It is in this feature that it departs radically from current practice.

A detailed discussion of the function of vertical steel in concrete columns would be too lengthy for this comment, but it is pertinent to point out that most of the existing codes, specifications, government regulations, etc. in Europe and in America require vertical steel in building columns, even though the column is heavily reinforced laterally.

It should be recognized that all building columns are subjected to bending action of varying degrees. Outside columns are subjected to bending action from the differences in temperature and humidity conditions between the exterior and the interior faces of the column. Both outside and inside columns are subjected to bending action due to unbalanced loadings, lateral loadings (wind and earthquake), non-uniformity of the concrete, and unequal settlements of foundations. Some of these effects cannot be adequately provided for in the design. It is the function of the vertical steel to provide the needed resistance to bending.

Vertical steel also performs a very useful function in reducing deflections under working loads (including the effect of plastic flow) and deflections due to shrinkage. With the working stresses recommended by Professor Lohr it would be possible, and even probable, that under working loads the top floor of a six-story warehouse would eventually have a settlement of 4 in. or more, due to the deflection of the columns, while with properly designed vertical steel this deflection could be reduced to a fraction of an inch. It is because of excessive deflections that most existing codes and specifications for building construction do not take full advantage of the high ultimate strength provided by lateral reinforcement. However, in structures where excessive deflections can be compensated for, high working stresses have been used for compression members. For example, Freyssinet in the Plougastel bridge and in other bridge structures used very high working stresses (up to 2,600 p.s.i.) for laterally reinforced concrete. In these cases, before the bridge was placed in service, he adjusted the arch ribs to compensate for the excessive shortening that was the result principally of the high stresses.

AN ENGINEER'S RECOLLECTIONS

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Through the Plains with the C.P.R.

A story of how a young engineer fared in the early days of building the Canadian Pacific Railway westward to the Pacific and how James J. Hill's strategy cut the cost of construction

EDITOR'S INTRODUCTION—No engineer now living has had the varied experience in engineering under pioneer conditions that has fallen to the lot of John F. Stevens. Born in Maine in 1853, Mr. Stevens began his engineering career there, but at the age of 21 went West and worked, first in Minneapolis in the city engineer's office and then in Texas on railroad location surveys. There followed two years on the D.& R.G. and about the same time on the Milwaukee; in all, a six-year period on railroad work that gave him a firm grounding in the fundamental requirements of railroad location and construction. In 1882 Mr. Stevens first came into indirect contact with James J. Hill when he became engineer for the contractor on the Canadian Pacific Railway work west of Winnipeg, work that is the subject of the following reminiscence; subsequently the two met and soon developed a mutual respect and confidence that culminated in Mr. Stevens' handling of the spectacular entry of the Hill lines into Oregon.

The C.P.R. work lasted until 1886, and for two years thereafter Mr. Stevens was on construction of the Duluth, South Shore and Atlantic. In 1889 he made his now famous discovery of Marias Pass as a route for the Great Northern through the Rocky Mountains; and the following year he located a line for the same railroad through the Cascade Range. Mr. Stevens continued in the service of the Great Northern almost continuously from 1890 to 1903, becoming chief engineer in 1895 and general manager in 1902. In 1903 he became chief engineer of the Rock Island, and in 1904 a vice-president.

On July 1, 1905, Mr. Stevens was appointed chief engineer of the Isthmian Canal Commission, a position which he held for two strenuous years, including a few months as chairman. In 1907 he resigned to return to railway work in the United States.

In 1917 Mr. Stevens accepted another difficult assignment, that of chairman of a commission of railway engineers that went to Siberia to rehabilitate the Russian transportation system.

Out of these varied and intensely interesting experiences Mr. Stevens has set down his recollections of several of the more spectacular events, and they are to be published in this and subsequent issues. —EDITOR.

JOHN F. STEVENS recounting one of the experiences of his early days in engineering

THE Canadian Pacific Railway in 1881-82 was completing its line from Montreal to Winnipeg; in fact, the end of its rails was then out on the vast prairies at a point 180 miles west of Winnipeg. At that time political conditions that threatened withdrawal of British Columbia from the Dominion were forcing the government to push the line through to an ocean terminal on the Pacific as fast as it could reasonably be done. Between the end of the track as it then existed and the Saskatchewan River, lay hundreds of miles of uninhabited treeless prairie, in whose rich virgin soil the plow had never struck a furrow. Beyond the river lay more than another hundred miles of prairie, rising rapidly into a plateau, then the foothills and the serrated peaks of the Rocky Mountains.

It was desired to push the rails as far west as could be done in a brief northern summer; to build to the Saskatchewan River in that short time, a hitherto unprecedented undertaking for which few contractors had either the organization, plant or the nerve to justify them in undertaking its completion. R. B. Langdon, of Minneapolis, and D. C. Shepard, of St. Paul, under the firm name of Langdon and Shepard, experienced and successful railroad contractors, took the contract, early in the spring of 1882, to build this extension in one season. Jas. J. Hill was then managing director of the road, and there was a rather neat exhibition of finesse between Mr. Hill and the contractors, as to the unit prices to be fixed for doing the work, in which Mr. Hill won out, as he usually did. The contract proved to be a profitable one, however, to the contractors, who were paid a fair price for their work.

Mr. Shepard was an engineer who had taken up contracting, a canny Scotch engineer and an extremely

shrewd man. Mr. Hill and he were old-time friends, and Mr. Shepard had a habit of dropping into Mr. Hill's office almost daily. Langdon and Shepard felt that they were the only contractors in the United States or Canada who had the resources, experience and personal following of subcontractors who could be safely entrusted to carry out the Canadian Pacific contract in one short season, and Mr. Hill knew it also, but he felt that their high bid prices reflected their knowledge of the situation.

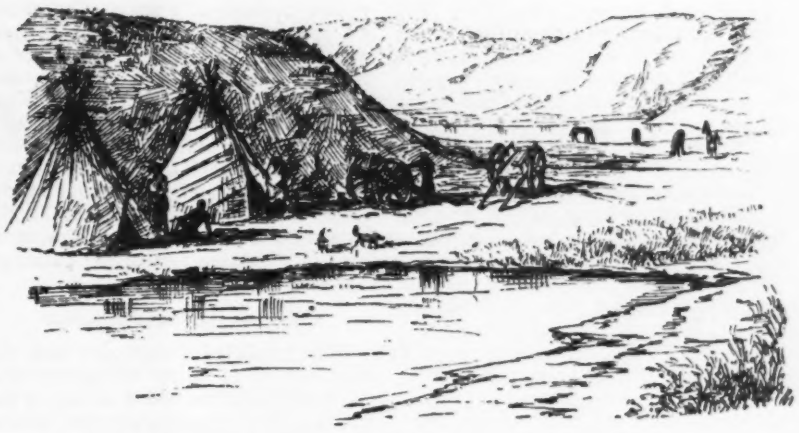
A day or two after Mr. Shepard had submitted their bid to Mr. Hill, he called, according to habit, at Mr. Hill's office. Lying on the desk, face down, was a telegraph form, on which was an ostensible lower bid of a former firm of large contractors in the Middle West, which had in years past handled large railway contracts, notably on the Union Pacific. In a few minutes Mr. Hill left his office, returning shortly after to find Mr. Shepard sitting as he had been, apparently unconcerned.

He left after some desultory conversation, and the next day Langdon and Shepard submitted a revised bid somewhat lower than that given in the supposedly genuine telegram. The revised bid gave prices which suited Mr. Hill, and it was promptly accepted by him. Years afterwards I personally heard Mr. Hill joke Mr. Shepard about the circumstance, but the latter only grinned and never made any denial.

Hill leaves the C.P.R.

Not long afterward Mr. Hill severed his connection with the Canadian Pacific, as he expected later to build his own road through to the coast, a competing line, and he properly did not consider that he should continue to have a voice in the policies of a rival road. W. C. VanHorne, afterward Sir William, was president of the Canadian Pacific and was its energetic driving head during the strenuous four years of its construction to the Pacific.

As the contractors proceeded to get their organization lined up and made ready for the summer's work, I accepted an offer to become engineer for the contractors, a position which did not call for any deep knowledge of the technicalities of engineering but did require some practical acquaintance with modern methods of handling the greatest amount of railroad construction in the shortest space of time and sufficient comprehension of the vagaries of human nature to enable a program to be followed that would ensure continuous and rapid work by the many subcontractors. I went at once to Winnipeg, to prepare for the strenuous summer which I anticipated, and I was not disappointed in my expectations. The spring season of 1882 opened up very late in the Northwest, the snow lying until well along into May. The water holes, called sloughs, were unusually large and frequent; there were no roads of any sort, and it was mud everywhere until nearly the middle of June. These conditions hampered and delayed the movement of plant and supplies, but energetic efforts day and night made it possible to get the work of grading and bridging well in progress during that month. This was followed by track laying, the building of the telegraph line and the many accessories to complete the road.



A CREE INDIAN ENCAMPMENT, from a sketch made by a Dominion Land Surveyor working on the Prairies at the time of the C.P.R. construction.

THE MAIN LINE of the Canadian Pacific Railway in the spring of 1882 was built only to a point about 180 miles west of Winnipeg. By the end of the working season it had reached the Swift Current River.

An efficient organization

The superintendents for the contractors were very able men, and almost at once the machine began to function in a wonderfully effective manner. I was kept busy on the line (we always had at least 125 miles of work in continuous progress) in driving back and forth, watching the subcontractors, checking up their estimates in order to know that they were getting proper credit for the amount of work that they were doing, and what was quite as important, seeing that they did not get overpaid by the head contractors. I used to drive much at night, which was comparatively easy to do, as there are only about five hours of darkness in that latitude in midsummer. I learned to sleep quite well in the buckboard while being driven perhaps 30 miles between sun and sun. I

did not get a very large salary that year, but I learned a great deal of the practical work from a contractor's standpoint, a knowledge which was to be of great value to me in the years to come.

The machine which Langdon and Shepard had so hastily put together moved like clockwork, the end of the track ever advancing and generally right on the heels of the graders. Every evening we could depend upon a certain number of miles of track to be laid that day, and within an hour after the last rail was down the telegraph alongside it was ticking away bearing news to, and getting news from the outside world. It was an absorbing drama that was played that summer by actors who knew their parts and carried them through without a break. When the approach of winter with its bitter cold and frozen ground forced a cessation of the work, we had finished track ready for operation as far as Swift Current River, as I recollect, and had nearly completed the grading for the rest of the line to the South Saskatchewan, a record which, I believe, had never been exceeded up to that time. The work closed down about the first of December, and I returned to my home in Minneapolis, where I remained idle during most of the succeeding winter.

McKenzie & Mann were our largest subcontractors. They graded some 75 miles of the line that summer and made a fair amount of money. Continuing on, they eventually financed, with government aid, and built 10,000 miles of the Canadian Northern Railway, and were knighted as Sir William McKenzie and Sir Donald Mann. But by dipping too deeply into some large projects both in Canada and abroad, they became badly involved and lost control of the railway, which was taken over by the Dominion Government, and now comprises the greater part of the Canadian National Railway system.

Northwest mounted police

The details of government and the maintenance of order throughout the Northwest territory were wholly in the hands of the Canadian mounted police. They were a wonderfully efficient body of men, and their history and record is too well known to require repetition. Many of its members were highly educated men, coming from the best families of the Dominion and the British Isles. The spirit of adventure lured most of them, and its attractiveness led them to adopt the service as their life work.

There was no disorder along the line during the progress of the work. One member of that much respected (and feared) force could police an extent of territory where we, south of the 49th parallel, would need 100 of our peace forces, which goes to show the difference in regard to respect for law which obtains between Canadians, British and Americans.

Cree Indians

The Cree Indians were numerous; they mostly hung around the contractors' camps, picking up offal or whatever they could find to eat, for they were a degraded lot. The Northern Blackfeet were west and southwest of the Saskatchewan River, with Old Crow, a friend of the white man, as "king," and they were peaceable. It was the next year, I believe, after our work on the plains, that Louis Riel, a French halfbreed, who had tried it once before, stirred up the Crees and halfbreeds and precipitated a massacre of some white settlers. The outbreak was soon quelled and Riel was hanged.

The policy of the Canadians in handling their Indian protégés differed very widely from that which our own government pursued with our Indians. The Canadians made no promise which they did not strictly fulfill. They did not rob the Indians through a lot of cheap political officials. We can call the Indians treacherous and cruel if we please, but, considering their centuries of savagery, their legends and customs, the actions of our plains Indians for many years succeeding 1860 stand out in true history in favorable contrast to our broken pledges and to our enforcement of the slogan that a good Indian is a dead one.

Australian Main-Line Railroads to Be Converted to Standard Gage

Formation of unit system makes good long-deferred maintenance-of-way proposed by federal railroad commissioner

UNIFICATION of gage on the railways of Australia as an unemployment-relief measure (since a large proportion of the expenditure would be for labor) and also as an economic development is urged in the 1934 report of George A. Gahan, commissioner of the Commonwealth Railways. This project has been advocated many times as essential to proper economic development of the country, which now has main lines of 4 ft. 8½ in., 5 ft. 3 in. and 3 ft. 6 in. in the five states. The railways of Australia aggregate 26,486 miles.

As far back as 1921, a special commission recommended the construction of two new lines to link up the existing standard-gage railways and the conversion to standard gage of all the lines of 5 ft. 3-in. gage. Again in 1929 the project was endorsed by a meeting of the railway commissioners of the several states. But as each of the five states owns and operates its own railway system (except for 2,145 miles owned and operated by the federal government), the project has a strong political aspect, and it has been impossible to get these state governments to cooperate in appropriating the necessary funds, in spite of the evident practical and economic advantages of a unit system of railways. Even on the standard-gage east-and-west transcontinental line, which is mainly standard gage, passengers have to change trains two or three times in the through trip where there exist stretches of 5 ft. 3-in. and 3 ft. 6-in. gages.

Since the report of 1929, about $21,750,000 has been spent on an extension completing a standard-gage route between Sydney (New South Wales) and Brisbane (Queensland), which formerly was a combination of standard-gage and 3-ft. 6-in., necessitating change of trains.

For the work remaining to be done, the cost would be about $105,000,000, to be extended over a term of seven years, or an average of $15,000,000 annually. It is pointed out that for a similar period ending in 1933, the total expenditure on railway construction in all the states was $310,000, or $44,300,000 annually. Thus, if one-third of the capital expenditures on construction had been applied to unification of the gages, the work would have been completed by this time. Of the $105,000,000 total, $56,500,000 would be spent in Victoria, $32,000,000 in western Australia, and $16,500,000 in south Australia. This would complete a standard-gage system connecting the capital cities of the five states and the capital city of the commonwealth. The local systems of 3 ft. 6-in. gage in Queensland and western Australia would remain unaltered, as the expense of their conversion to standard-gage would not be warranted.

Another relief measure proposed by Mr. Gahan is to make good the deferred maintenance-of-way, resulting from the period of depression. For example, extensive tie renewals are now becoming necessary, the estimate being for 300,000 to 400,000 ties for the federal railways alone in 1935. It is recommended that unemployment-relief funds should be spent on this work, which would give employment to a large number of men.

Large Los Angeles Store Given New Strength and Appearance

Structural repairs coupled with facade modernization make remarkable improvement in large building damaged by earthquake

By Edward L. Mayberry
Architect and Engineer
Long Beach, Calif.

SINCE the earthquake of March 10, 1933, in southern California many buildings in the areas affected have been remodeled and in some cases so improved as to become modern structures, architecturally and structurally. One such building is that of the J. W. Robinson Co. in Los Angeles, one of the largest retail dry-goods and department-store establishments in the country. Owing to the unusual nature of the exterior brickwork, much of the building was supported clear of the structural frame and suffered considerable damage during the earthquake. This damage was further aggravated by the fact that the building consisted of two structures of different materials with different periods of vibration. The original building, built in 1914 (a seven-story and basement reinforced-concrete structure) and the annex, built in 1924 (seven-story structural-steel frame, Fig. 2), were not tied together in any way. The direction of the shock was from southwest to northeast and acted on the narrow bases at nearly right angles to the line of contact between the two buildings. The result was that the steel-frame annex with its more rapid period of vibration hammered the main concrete structure.

The exterior brick pilasters and spandrel sections on the Hope St., or west elevation, were considerably cracked and loosened, and in the repair of the structure it was deemed best by the management to remove all of the exterior brick facing and replace it with reinforced pneumatically placed concrete, at the same time modernizing the appearance of the building.

Tying buildings together

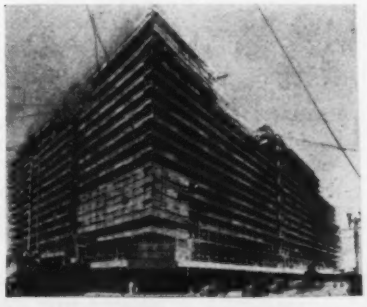
In the repair of the building new and unique construction methods were developed and used. To prevent the hammering of the two buildings in a recurring seismic disturbance, they were tied together in such a manner as to prevent them from separating as they rocked on their bases. This was done by fastening together adjacent columns of the two buildings by means of yokes (Fig. 4) consisting of two U-shaped overlapping steel plates bolted together at the point of contact of the two columns. A slot was bored between the columns in which were inserted two steel plates, between which there was placed a ball-bearing race of 1½-in. steel balls packed in grease. Any difference in size or irregularities of the columns was removed by dry-packing in cement. These yokes were placed on some fifteen pairs of columns immediately below the roof slab and on top of the seventh, sixth, fifth and fourth-floor slabs. They will prevent the two buildings from separating, at the same time permitting them to slide against one another vertically, as they oscillate in a seismic disturbance. The yokes were so designed that their strength is less than the shearing strength of the weaker column.

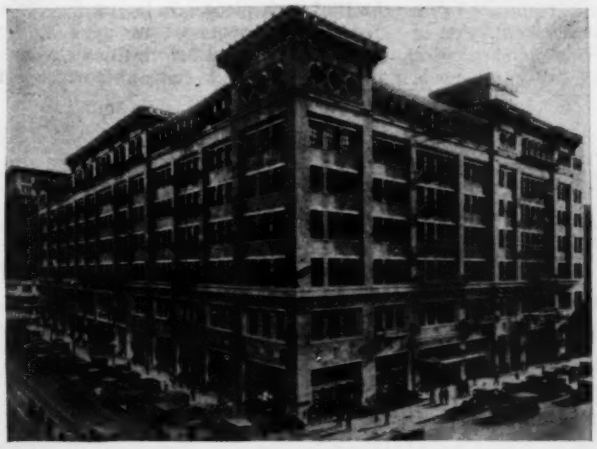
Nearly all of the yokes were in place at the time of the Oct. 2, 1933, earthquake shock, which was quite sharp in Los Angeles. It was positively demonstrated that the yokes fulfilled their object in that the building did not separate, and there was visual evidence that there was a slight movement on the vertical plane between the adjacent columns.

Wall repair

The exterior walls of the original building were brick with a glazed-brick, veneer-face finish. There were 8-in. brick filler or curtain walls on the line of the structural frame, with hollow brick pilasters and many hollow spandrel sections outside of the frame, forming the architectural façade (Fig. 6). These hollow sections were inadequately anchored and showed typical diagonal and horizontal earthquake cracks. All the brickwork outside of the line of the face of the structural framework as well as the face brick was removed, and the architectural exterior was carried out in a reinforced pneumatically-placed concrete shell averaging 4 in. in thickness, all of which was securely anchored to the structural frame (Fig. 3). This new exterior shell was designed to resist a

FIG. 1—BEFORE, during and after the remodeling of a large department store in Los Angeles. The brick pilasters and mullions of the original facing not being tied to the structural frame constituted a distinct hazard in earthquakes. The new tile facing is attached to pneumatically placed concrete backing securely anchored to the frame and designed for lateral loads of 100 per cent of its weight.





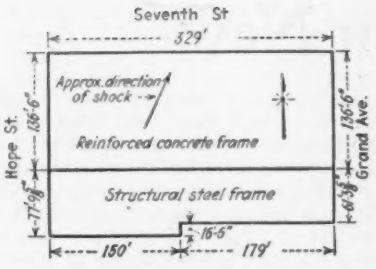


FIG. 2—PLAN and dimensions of Los Angeles department store. The two types of construction, vibrating at different periods during the 1933 earthquake, resulted in considerable damage.

lateral force equivalent to 100 per cent gravity.

The removal of the brickwork and the use of a concrete shell relieved the structure of a net dead load of over 6,000,000 lb. This will reduce very materially the lateral force acting on the building during any seismic disturbance, and will eliminate the hazard of falling material.

Upon removal of the exterior brickwork to the face of the structural framework, it was found that some of the reinforced-concrete spandrel beams were fractured. All fractured beams were shored up, clipped out, additional reinforcement was installed and repaired with cement-gun work, making them stronger than before. Chases were cut along the sides of the brick filler walls, and this space was filled with pneumatically-placed concrete, to improve the anchorage of these panels to the structure. Also, about 1 in. of concrete was shot on the face of these brick panels, to tie the bricks into a more monolithic unit.

Paper-backed wire mesh bent to shape was used as backing and forms for the new concrete shell. Over this were placed the horizontal and vertical reinforcing bars, and on top a 2x2-in. No. 12 welded fabric bent to conform to the finished architectural lines of the building. On the two lower stories U-shaped loops were hooked in back of the reinforcing, and after the gun work was completed the rods were threaded through these and the terra cotta facing was anchored to them. The pneumatically-placed concrete, 4 in. thick, was applied over this reinforcing and mesh and the surface was heavily scored, to improve the bond with the facing tile. On the main pilasters horizontal diaphragms of reinforced concrete were shot at floor levels and mid-points between floors (Fig. 3). The horizontal steel reinforcing in these diaphragms extended 2 ft. beyond the edge of the diaphragms, and the alternate bars were bent up and down at right angles and tied securely to the vertical steel in the outside shell. These diaphragms are anchored to the structural frame. At the floor levels they carry the vertical load of the exterior shell as well as act as cross-bracing for it.

In the sides of the mullions between the windows and of the main pilasters, vertical arc-welded trusses encased in the concrete shell were used to support the vertical load. They were securely anchored top and bottom to the structural frame and cross-braced every 8 ft. to take the horizontal stress due to lateral thrust.

The two lower stories of the building were finished with machine-made terra cotta tile 1¼ in. thick, while the upper portion of the building was finished with thin 2x6-in. and 2x2-in. tile made with heavy vertical dovetail keys and deeply scored.

The terra cotta facing was joined by two steel dowels extending about 2 in. into each piece of terra cotta above and below the horizontal joint. Ties of No. 6 wire around these dowels and to the rods through the U-shaped loops in the walls served to anchor every piece of terra cotta. The space behind the terra cotta was poured full of a thin rich cement grout.

The tile for the upper stories was made with two dovetail grooves on the back of each piece. In laying the tile a 1:4 mortar brown coat was applied over the gun work, and before this had thoroughly set, a 1:1 cement mortar was

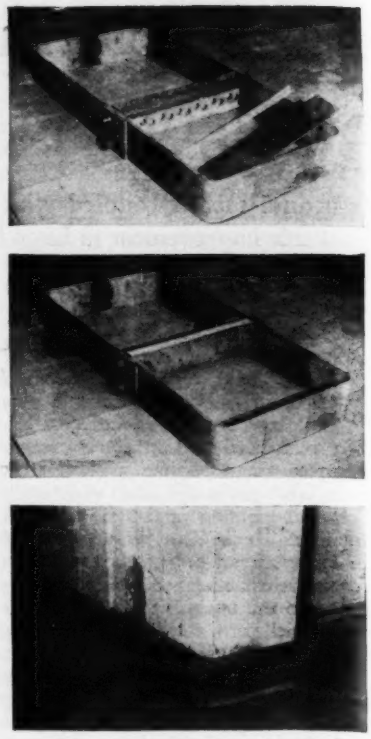
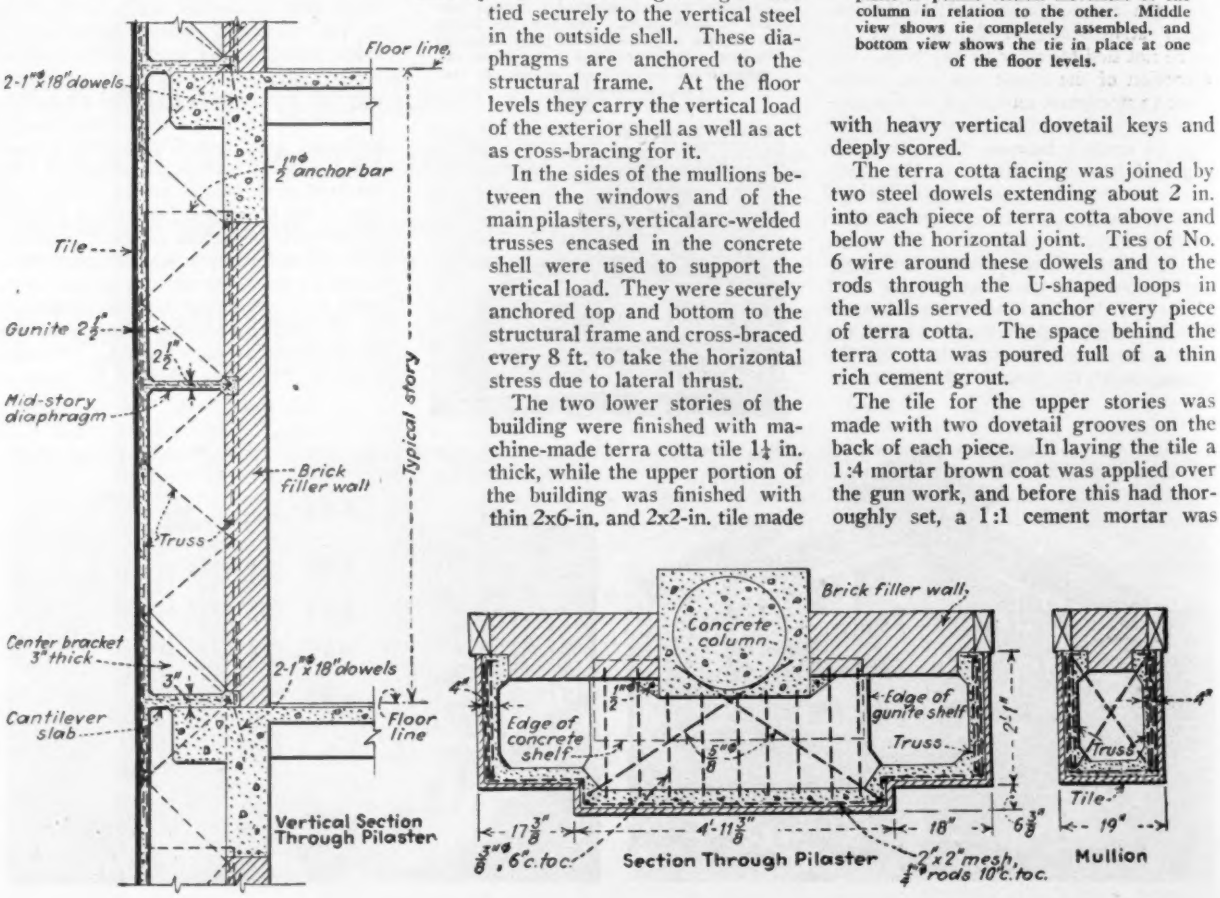


FIG. 4—THREE VIEWS of steel yokes used to tie adjoining columns of structural-steel and reinforced-concrete portions of buildings together. Top view shows steel ball race, which is inserted between cross-plates to permit vertical movement of one column in relation to the other. Middle view shows tie completely assembled, and bottom view shows the tie in place at one of the floor levels.

FIG. 3—DETAILS of reconstructed exterior walls, with pilasters and mullions formed of reinforced, pneumatically placed concrete securely tied to the structural frame.



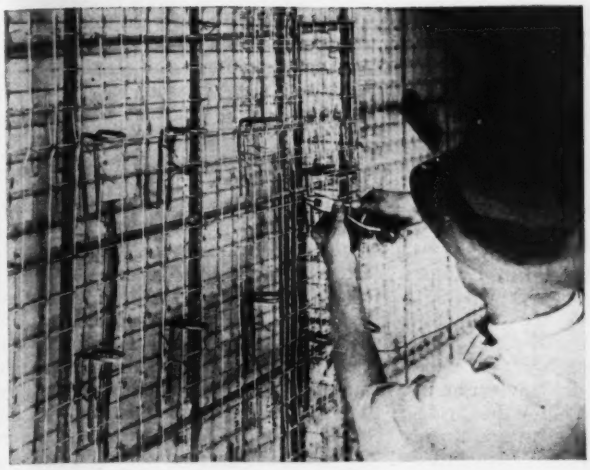


FIG. 5—NEW EXTERIOR wall surface consists of reinforced, pneumatically placed concrete shot against paper-backed mesh.

FIG. 6—TYPICAL construction of old facing, showing brick mullions outside of structural frame and without lateral support.

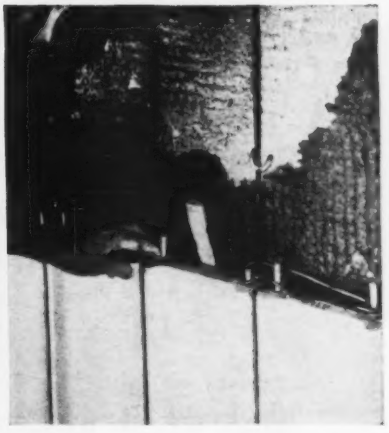


FIG. 7—NEW FACING consists of terra cotta blocks in the lower two stories (right) and of tile in the upper stories. Note anchorage of terra cotta to concrete backing.

applied. The grooves in the back of each tile were filled with this cement mortar, and the tiles were then pressed into place on the bedding mortar. To assure equal joints, ¼-in. round rubber strips were temporarily laid in the joints, and a water level was used to preserve a true alignment of the joints around the building. After the mortar had thoroughly set, the rubber strips were removed and the joints filled with grout.

All of this exterior wall work was done from tubular pipe scaffolding. At one time the entire exterior, some 90,000 sq.ft., was enclosed by this scaffold.

The business of the firm was carried on without interruption during the entire repair and remodeling operations. The repair of the earthquake-damaged interior plaster was done outside of business hours. All materials, apparatus and staging were taken in and out of the building nightly between the hours of 5:30 p.m. and 6 a.m. This necessitated the nightly covering up and protection of all store fixtures, carpets and merchandise with waterproof building paper and planking.

The cost of the repair and remodeling work exceeded $450,000. The writer was the designing and supervising architect and engineer of the project. Earle S. Marsh was architect's superintendent and engineer. Richard-Neustadt Construction Co. was general contractor; Ed Westberg, plastering and Gunite work contractor; E. A. Irish, wrecking contractor, and B. V. Collins, tile contractor.

Model of Cape Cod Canal Built to Aid Hydraulic Study

A 115-FT. MODEL of the Cape Cod Canal on a scale of 9-ft. per mile is being built at the Massachusetts Institute of Technology to facilitate studies of flow in connection with the projected enlargement of the waterway to a 700-ft. width and 40-ft. depth. The work is being done under the direction of Prof. Kenneth C. Reynolds of the civil engineering department, cooperating with Col. John J. Kingman, U. S. Engineer Corps, Boston.

The model will be of concrete and sand, to form a channel accurately representing the curving path of the canal across the Cape; the reproduction of Buzzards Bay alone, with its islands and inlets, will occupy a space of 35x50 ft.

Enlargement of the canal is expected to change the sea levels at both ends and to alter the current velocities through the waterway. At present the flow is about 13.5 m.g. per min., and after enlargement this is expected to rise to 75 m.g. The ebb and flow of the tides, which are non-synchronous at the ends today, will be reproduced, and various floats will record the effect of currents and wave motion.

In previous studies in the institute's river hydraulic laboratory on a smaller model of the canal, methods were devised to reproduce waves ranging from slight ripples to the full surge of the tide.

Pneumatic-Caisson Practice in Soviet Russia

Developments by Russian engineers include wood-reinforced concrete, hollow-wall design for floating boxes, new types of air locks and interesting methods of winter sinking

By M. A. Kienia
Chief Engineer of Railroad Bridge Construction, U.S.S.R., Leningrad

IN BUILDING foundations for bridges in the Soviet Union, pneumatic caissons are employed almost to the exclusion of open caissons and sheetpile cofferdams. This is because the many large construction operations of Soviet Russia have caused a shortage of cranes and clamshells and of long metal sheetpiles. Pneumatic caissons are mainly used for bridge piers, but they have also been used for the foundations of industrial buildings. At present they are being used for the construction of the subway in Moscow, and large caissons will also be used during 1935 for the foundation of the Palace of the Soviets.

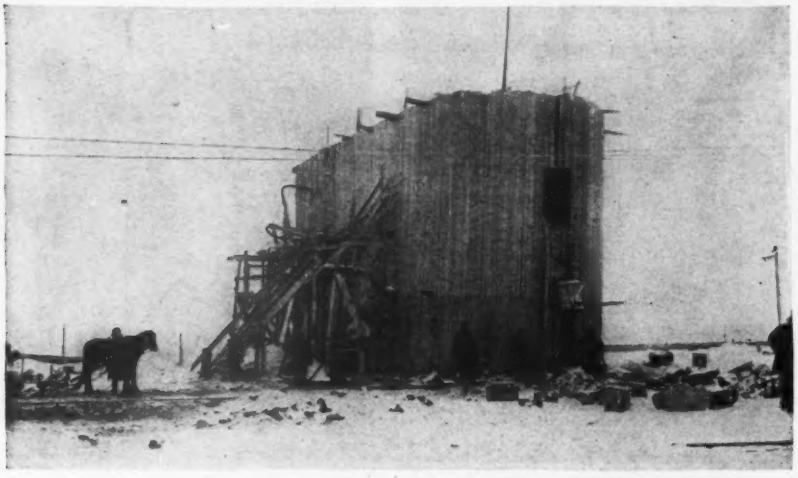


FIG. 1—WINTER CAISSON SINKING on the Volga, Russia. Caisson is one of seventeen for the Saratov bridge. All materials were brought out from shore on a narrow-gage railway on the ice.

Notable pneumatic foundations

Since 1927 seventy large bridges have been built in the U.S.S.R., and fully 300 bridge-pier caissons have been sunk. Some of these bridges deserve mention.

The railroad bridge over the Dnieper River at Dnepropetrovsk has a length of 5,350 ft., and 4,600 ft. of this length consists of reinforced concrete arches; there are 37 spans.

The steel bridge over the Volga River at Saratov is 5,570 ft. long and has sixteen spans, of which seven spans are over the main channel of the river. The two spans used for navigation are 658 ft. each. The piers for this bridge, built on pneumatic caissons, are already finished, and the steel superstructure is being erected.

Another bridge over the Volga River at Gorki was finished in 1933. It is 3,280 ft. long, and 2,230 ft. of this length consists of concrete arches with 180-ft. spans. At Gorki there is also a street bridge consisting of six long steel arches. The caissons for a street bridge over the Neva River at Leningrad have been sunk. Several other large bridges have been built besides a great number of bridges of ordinary lengths.

The pneumatic caissons for these bridges vary considerably in size, the smallest being 560 sq.ft. and the largest 4,750 sq.ft. in area. In the near future there will be built and sunk a caisson with an area of 7,100 sq.ft. The maximum depth to which six of the caissons for the Saratov bridge were sunk was 49 ft. of water plus 49 ft. of ground. The area of these caissons was 1,470 sq.ft. The two caissons for the Neva bridge at Leningrad were sunk 52.5 ft. in water plus 39 ft. in ground.

When the present great activity in bridge building in the U.S.S.R. began, most of the pneumatic caissons were constructed of reinforced concrete, the caissons being designed as a slab resting on circumferential elastic support. Very few wood caissons were built, and only two or three were of structural steel.

A radical change in caisson construction took place in 1929 during the building of the bridge over the river Dnieper at Mogilov, when the author designed, built and sunk a caisson of a composite timber-concrete construction (Fig. 2). Instead of steel bars there was used a reinforcement of boards and battens of pine and fir. The general principles of design were the same as for a caisson reinforced by steel bars, but with a change in the modulus of elasticity and unit stresses. The first caisson had an area of 485 sq.ft. and was sunk to a depth of 33 ft. below the surface of the ground.

During the sinking of the piers for the bridge over the Volga at Saratov, further experience was gained: nine timber-concrete caissons were sunk, their areas being an average of 775 sq.ft. and their width 24.6 ft. After the successful experience on this bridge, all pneumatic caissons are now built of the timber-concrete type, except caissons sunk in exceptionally deep water by the floating method. A still larger width and area of caissons was reached in building the reinforced-concrete bridge over the Oka River on the Moscow-Donbas Railroad. The width was 41 ft., and the depth sunk was 82 ft. of water and ground. More than 200 timber-concrete pneumatic caissons have been sunk in the U.S.S.R., all of them successfully.

Building wood-concrete caissons

After the cutting edge of the caisson has been placed and the inner formwork has been built, the timber reinforcing frame is constructed. It consists of boards and batten plates, the boards being placed with their largest dimension in a vertical plane. The batten plates are nailed to the boards, which constitute the main reinforcement. After the inner-wall reinforcement and lower-roof reinforcement has been placed, the outer-wall reinforcement and upper-roof reinforcement are placed. Shearing stresses are resisted by steel stirrups. A series of tests made under the supervision of the writer proved that timber stirrups do not work out well but decrease the stiffness of the construction.

The wood should be dry; the drier the wood the better is the bond between timber and concrete. The working unit stress for tension on wood is 2,130 lb. per sq.in., and the ultimate tensile strength is 6,250 lb. per sq.in. The permissible bond stress is 35 lb. per sq.in. The ratio between the moduli of elasticity of timber and concrete was assumed to be 0.5 in the first timber-concrete design, but a series of tests led to the conclusion that this ratio is be-

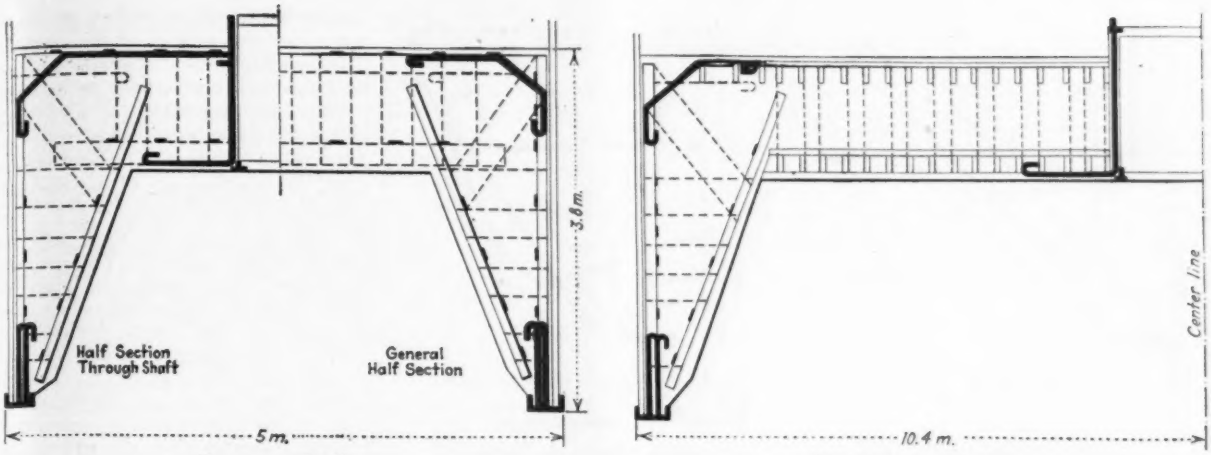


FIG. 2—WOOD-REINFORCED concrete caisson for the Mogelov bridge over the Dnieper River, Russia.

tween 1.0 and 1.5 The ratio assumed in present designs is 1.

Hollow-wall floating caissons

The solid timber-concrete caisson is the prevailing type on shore and in shallow water; but when caissons must be sunk in deep water, they are built hollow, like concrete barges, with thin walls reinforced with steel bars, so that they can be floated into position. The floating caissons for the bridges over the Volga River at Saratov and over the Neva at Leningrad are of particular interest. Fig. 3 shows the design of one of the Saratov bridge caissons with the steel reinforcement in place. The thickness of the walls of these hollow floating caissons is 4 to 6 in., and of the beams and ribs 12 to 16 in.

The concrete is made so dense that water cannot penetrate it. If the working unit stress is 510 to 710 lb. per sq.in., the ultimate strength should be 2,850 lb. per sq.in. To waterproof the concrete in one of the Leningrad caissons, it was coated with a thin layer of gunite. The reinforcement in floating caissons of this type, reinforced entirely with steel bars, is from 0.6 to 1.2 per cent.

The design of the cutting edge of the caissons has also undergone radical changes during the last five to six years (Fig. 4). The cutting edge formerly used weighed from 120 to 133 lb. per linear-foot. This was changed and lightened during the building of the Saratov bridge. During the building of the bridge over the Dnieper at Dnepropetrovsk, the caissons with cutting edges of the new type cut through rocks and boulders without being damaged, although the cutting edge weighed only 27 lb. per linear-foot.

Sinking caissons

The following three methods of caisson sinking are the only ones used; (1) sinking the caisson on the shore of a river, in which case a surface excavation 5 to 7 ft. deep is made for the caisson if the groundwater permits it; (2) sinking the caisson on an artificial island; and (3) sinking a caisson which previously has been constructed in a dock or on the shore by the floating method.

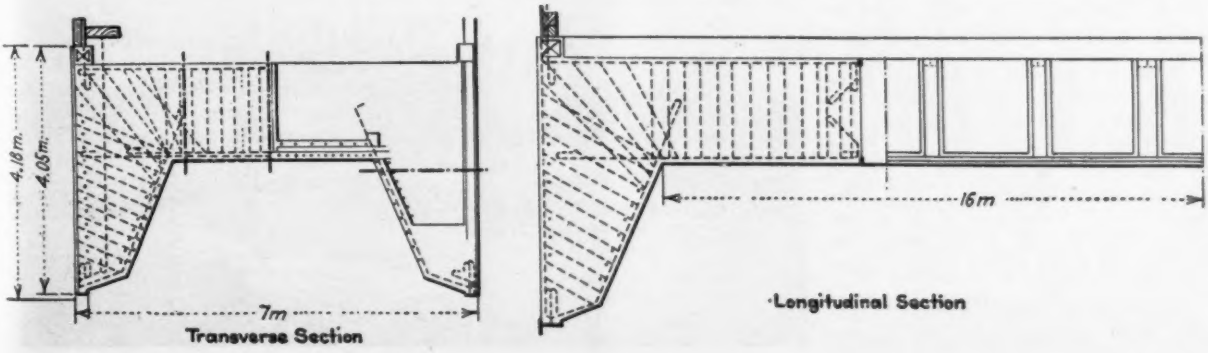
Caissons are rarely lowered by means of chains, as the method is cumbersome and expensive; it was used only in the period prior to the perfection of the floating method of caisson sinking.

The method of sinking the caisson on an artificial island is used extensively in rivers with a depth up to 16.5 ft.

FIG. 3—FLOATING CAISSON for Saratov bridge over the Volga utilized hollow walls of reinforced concrete.

In special cases, for instance, the sinking of caisson No. 3 of the bridge over the Ob River at Novosibirsk, the island was built in water 21.3 ft. deep. The islands are built by suction dredges, are not completely enclosed by sheetpiling but are protected against the current by a breakwater of sheetpiling on the upstream side. The suction dredge deposits the sand at its natural slope, from 1 on 7 to 1 on 10, depending on the coarseness of the sand. Only rarely is the caisson endangered by scour.

The reliability of the island method was proved during the building of the bridge over the Oka River at Kashira on the Moscow-Donbas Railroad. The islands were built in the fall of 1932 and were located in the main channel of the river, the farthest 1,100 ft. out. They were built up by a suction dredge, were not enclosed and were not even protected against scour. Four caissons of a composite timber-concrete type, with areas from 2,000 to 2,200 sq.ft., were erected on the islands during the following winter with the intention of sinking them before the spring flood came. For several reasons, and particularly on account of delay in receiving the air compressors and because the spring flood came exceptionally early, only one caisson out of the four had been sunk to a depth of 33 ft. The other caissons were left standing during the period of high water and ice flow in the main channel. The water



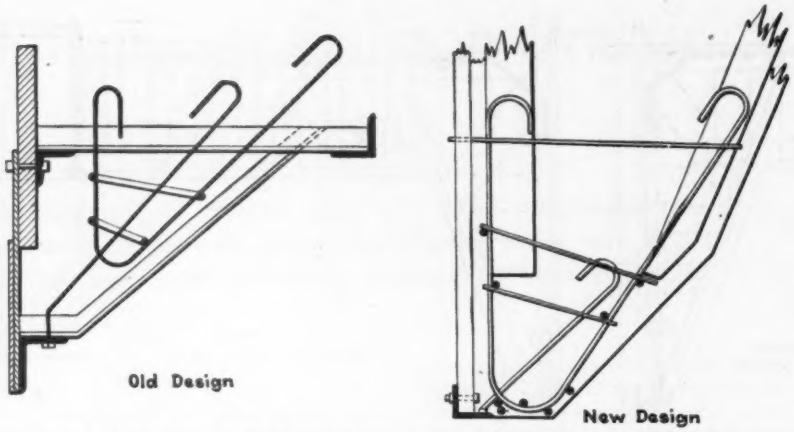


FIG. 4—CUTTING EDGES, old and new, as used on Russian caisson work. The old design weighed as much as 133 lb. per linear-foot, while the new design weighs only 27 lb. per linear-foot.

rose 23 ft. and completely flooded the caissons. The velocity of the water was 4 ft. per second.

The flood period, which began when the ice started to float, lasted from April 5 to June 1, 1933. But although the velocity of the current was twice the velocity during the construction period, the islands did not suffer any serious damage. All were reduced about 3.28 ft. in height by scour, which slightly unbalanced the caissons during the sinking. The largest inclination occurred at caisson No. 7; its downstream end settled more than the ice breaker end, and it also leaned toward the right shore. The largest inclination downstream was 7.2 ft.; toward the right shore 5.9 ft.

During the construction of the islands the maximum depth of water was 14.75 ft. The surface of the islands was 3.28 ft. higher. The fineness modulus of the river sand at this place was 3.

If the depth of the river is from 16.5 to 23 ft., the artificial islands are built inside a sheetpile enclosure, which is made either two-ply or one-ply, depending upon the method of wall bracing.

Deep caissons

When it is necessary to sink caissons in water with a depth of 23 ft. or more, floating caissons are generally used. Six floating caissons with a sectional area of 1,460 sq.ft. each were built and sunk under the writer's direction during the construction of the bridge over the Volga River at Saratov in 1930 and 1931.

Under the direction of engineer Ivanshenev, two large caissons were built and sunk in 1933 during the construction of the bridge over the river Neva at Leningrad. The sectional area of each of these caissons was 4,750 ft. The depth of the Neva was 52 ft. at one caisson and 42.5 ft. at the other. At Saratov the depth of the Volga ranged from 39 to 50 ft.

All in all there were seventeen caissons built and sunk for the Saratov bridge. Six of these were sunk by the floating method, one on an artificial island constructed in water 14.8 ft. deep, and the rest on land. The floating caissons were made of concrete reinforced with steel bars and were built in a floating dock.

The draft of the caissons was 18 ft., but the deck of the dock could not be lowered to a greater depth than 13.8 ft. below the water; so to remove the caisson from the dock by floating it was necessary to force the water out of the working chamber by air pressure, and thereby decrease the draft of the caisson. When the caisson floated freely, it was towed out to deep water (Fig. 5). The height of the caisson was 15.6 ft., and a watertight timber-cofferdam was built on top. The cofferdam was sheeted with two layers of 2-in. boards and was carefully calked. It was very satisfactory and did not leak. The intention had been to sink the caissons by means of a floating scaffold with a lifting capacity of 350 tons. This scaffolding had 22 screws 2.5 in. in diameter. Chains were suspended from these screws and supported the caisson while it was sinking under the weight of the concrete. This method of caisson sinking was used for only one of the six caissons.

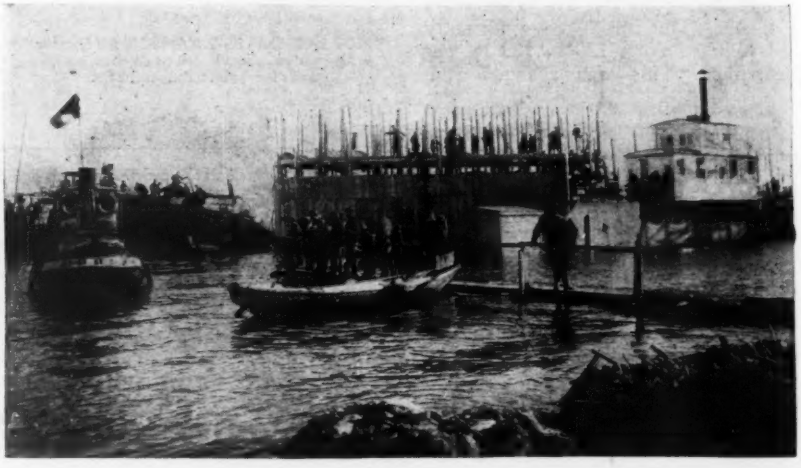
The other five caissons were sunk in deeper water after being towed to their proper positions and anchored with ropes connected to the top of the concrete part of the caissons. Fig. 1 shows the sinking of one of these caissons without crane scaffold. The concrete was deposited in successive layers or rings inside the cofferdam, which also served as sheeting for the hollow pier. A slightly different method was followed in concreting caisson No. 7. Instead of depositing the concrete in successive rings, it was deposited by continuous pouring. In this case the hydrostatic pressure of the water on the cofferdam reached 16.4 ft., but it was unnecessary to use pumps.

The main disadvantages of sinking by means of a floating scaffold are: (1) the high cost of building a powerful floating scaffold; (2) the expense of chains and screws; (3) the inconvenience of lowering the caisson at the same time as the shaft is increased in height, which greatly increases the difficulty of sinking; and (4) the impossibility of erecting the cofferdam to the full height at once.

All these disadvantages and the added expense are avoided by sinking without chains. The high-water pressure is not dangerous provided the cofferdam is well built. This method also has the great advantage that it is possible to sink several caissons simultaneously. We used this advantage to its full extent, by sinking three floating caissons simultaneously. With only one floating crane available, it would have been impossible to do this with the chain and screw method.

The sinking of the caissons was facilitated by choosing the winter as the working season; this greatly facilitated accessibility to the caissons, also mak-

FIG. 5—HOLLOW CAISSON for Saratov bridge being towed out of dock to site in bridge.



ing it possible to anchor them to the ice.

The concrete was mixed on the shore and was delivered to the site in round buckets over a narrow-gage track, laid on the ice. The concrete was heated by steam. When it was poured from the mixer, its temperature was between 50 and 60 deg. F. Although 2 to 3.6 deg. were lost during the transportation, the temperature three or four hours after the time of depositing was nevertheless from 59 to 68 deg. due to the heat developed by the concrete itself.

The caissons for the Leningrad bridge were built on shore and were sunk there to a depth sufficient to float them. Then a suction dredge dug a channel for them, and they were floated out into the main channel. The caisson was anchored with cables to a barge located 230 ft. upstream. This arrangement provided a good control of the alignment. It has already been mentioned that the sectional area of one caisson was 4,750 sq.ft., the width was 36 ft. The caisson was sunk in 52.5 ft. of water, and strong anchorages were needed to keep it in position.

The anchors were of reinforced concrete and weighed 6.6 tons each. The caissons were sunk during the summer of 1933. There was a very heavy river traffic, and several ships and rafts collided with the anchorages. One large raft with 26,000 cu.yd. of export lumber hung up on the anchor cables. The anchors and cables withstood the pull so well that the caisson was only pulled downstream 1.6 ft. To avoid further damage and to facilitate the removal of the raft by a tugboat, the raft was broken up and drifted downstream.

The concrete for the caissons was delivered by a cableway from the mixing plant on the shore. The construction and sinking of the caissons were exceptionally successful. The work was performed under the directions of two young engineers, Ivanschenko and Shneskov, who had taken part in the work at Saratov.

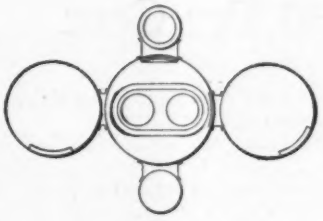
Many different systems of airlocking were used in the U.S.S.R. prior to 1926. But since then only the two best systems have been widely used—those of F. N. Tulenev and of N. T. Fillipov. The latter is somewhat less extensively used than the former. The Tulenev type of airlock is shown in Fig. 6; the working principle is as follows:

The shaft is separated into two half-shafts through which two buckets pass up and down. Each bucket has a capacity of 3.5 cu.ft. The workers pass up and down through the same shaft. The airlock has a central chamber and four side chambers—two of which are manlocks, while the other two locks serve the buckets with the excavated material. When a bucket, filled with excavated material, is lifted to the top of the central chamber, it is caught by a bracket fastened to the inner door of one of the material locks. This door closes, thereby carrying the bucket into the material lock. When the air pressure in this lock has been reduced to the pressure of the atmosphere, the outer door moves aside and the bottom part of the bucket is swung outside while the bucket is yet suspended from the bracket. The bottom lid of the bucket is opened, and the excavated material drops down through chutes. From 50 to 60 buckets pass out during one hour with 8 to 9 cu.yd. of excavated material. It is rarely, however, that more than 160 cu.yd. are removed during one day (24 hours) on account of delay in the airlocking.

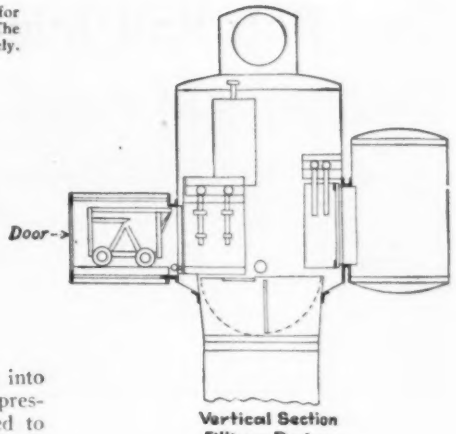
The Tulenev system has the disadvantage that if two buckets, passing up and down, come to a stop at the same elevation in the shaft, the workers have no free access to the manhole. It is therefore the intention to reconstruct all the airlocking systems of this type.

The working principle of the Fillipov airlock (Fig. 6) is as follows: Only one bucket passes up and down in the shaft. The capacity of this bucket is 5.3 cu.ft. The airlocks consist of two chambers for men and one for material.

FIG. 6—TWO TYPES of air locks for pneumatic-caisson work in Russia. The Tulenev design is used most extensively.



Plan
Tulenev Design



Vertical Section
Fillipov Design

When the bucket filled with excavated material is lifted to its highest position, a small car moves out from one of the material chambers until it is under the bottom of the bucket, which then is opened so that the material drops into the car, which then is returned to the material lock and is airlocked through it. When the car is outside, it can be moved to any convenient place and emptied by opening the bottom of the car. This airlock has only 75 per cent of the efficiency of the Tulenev airlock. It fulfills the requirement of giving free access to the manhole for the workers, but it needs highly skilled workers for its operation. In the U.S.S.R. there is no entirely separate airlock system used for the workers. The airlocks in use are designed to accommodate both men and materials. The working chamber is finally filled with concrete by means of these same airlocks; but for that purpose special concrete buckets are used in the Tulenev system.

Metallurgical Cutting With Oxy-Acetylene

A SPECIAL article in the magazine *Oxy-Acetylene Tips* reviews the remarkable and rapid growth of oxy-acetylene cutting from a mere severing process to one having general application for fabricating, finishing and shaping iron and steel materials. Furthermore, the process is rapidly coming to have a predominantly metallurgical aspect. The problem no longer is how to cut a given shape but how to cut a given steel. It is this fact that has suggested the term "metallurgical cutting."

All oxy-acetylene cutting at the present time may be grouped under two major headings, flame-cutting and flame-machining. The first of these includes all uses of the flame for severing metals. Appropriate techniques have been developed for different types of ferrous metals such as low-carbon steel, cast iron, stainless steels, and those which require a flux of low-carbon steel.

Flame-machining is a development of the past two years. It is based upon the chemical reaction between iron and oxygen as in flame-cutting, but the purpose is not the severing of metal but the removal of a predetermined depth and width of metal by impinging the cutting oxygen jet on the surface at an acute angle. Its application may be classed under five different headings: planing, milling, turning, drilling and boring.

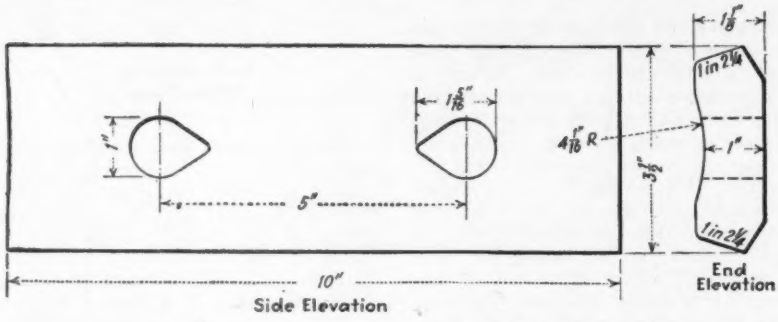
Under the first of these, the operations of deseaming, hogging and surface planing have had considerable commercial use. Flame milling includes the use of the flame for longitudinal fillet cutting for special edge contours, and the sinking of regular planing cuts. By flame turning, screw threads and various special milling cuts can be produced with proper adjustment of the cutting oxygen stream. Flame drilling and flame boring have as yet had but little attention.

Two-Bolt Rail Joints in England Cut Splice Material 50 Per Cent

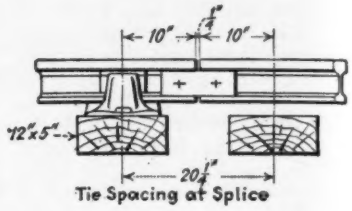
A RADICAL DEPARTURE from typical rail-joint design that has been introduced on all the English trunk-line railways is the use of a short two-bolt splice in place of the usual four-bolt type. The long six-bolt type of joint, extensively used on American railways, has never been favored in England. Taking the Great Western Railway as an example in its former standard design of track, the 45-ft., 95-lb., bullhead rails, laid with square joints, had 18-in. plain fishplate splices with four bolts spaced 4½, 5 and 4½ in. c. to c. These bars weighed 32¼ lb. per pair. The joint ties were spaced 24½ in. c. to c., the shoulder ties 27½ in.; the next, 29 in., and the intermediate ties 31 in., there being eighteen ties to each 45-ft. rail length.

For the new type of rail joint, the fishplates are only 10 in. long, weighing 18 lb. per pair, having two bolts spaced 5 in. c. to c. The tie spacing at the joints is reduced to 20¼ in.; then 27½ and 29 in. for the next two spacings, and approximately 31¼ in. for the 13 intermediate ties, there being eighteen ties per rail length, as before. More recently, however, the standard length of rail has been increased to 60 ft., with 24 ties per rail length and approximately the same arrangement of tie spacing. The saving in joint material with the new splices is considerable, and breakages of splice bars are expected to be reduced materially. However, on curves of more than 3½ deg., the four-bolt splices are still used because of the lateral stiffening to the joints.

While the spacing of the joint ties is reduced for the new short splices, it may be noted that with the English bullhead rail carried in cast-iron chairs, the unsupported length of the rail ends is still greater than it would be with the American type of track having T-rails supported on tieplates and with ties of 20¼-in. spacing. With the relatively narrow chairs, the unsupported length between the bearings in the chairs is about 16 in. With tieplates approximately the full width of 8-in. ties, this distance would be 12 in.; or with 8-in. ties placed 8¼ in. apart in the clear (the same clear spacing as the English 12in. ties), the unsupported length would be only about 9 in.



TWO-BOLT SPLICE PLATES as used on Great Western Railway in England.



Horse-Drawn Fresnos Construct Large Canal as a Relief Project

LAST SUMMER there was a water shortage in the Imperial Valley so serious that farmers lost their crops and in a few cases even their stock. An appeal for federal aid was made, and last fall a 7-mile branch of the All-American Canal west of Calexico was undertaken purely as an emergency relief job. The work was done under the direction of the Bureau of Reclamation on the force-account plan, with employment limited to farmers of near-by communities. This portion of the canal is a plow-and-scraper job, and the size of the waterway is so large that teams could be grouped together to advantage. For the most part the workmen kept their teams in camps adjacent to the canal, presenting a scene typical of construction camps years ago before the economy of power equipment supplanted the mule. The undertaking employed about 300 men and 900 head of stock, resulting in a payroll of about $10,000 per week, which entirely changed the financial situation for the winter season in the communities affected.

This portion of the canal will not be needed for some years and was undertaken at this time wholly as a relief measure. Construction started at a point about 3 miles west of Calexico, and the canal was built 7 miles to the west. The capacity is to be 2,600 sec.-ft. The bottom width is 60 ft., side slopes 1½:1, water depth 11.3 ft., bank height 15.8 ft., and bank crown width 20 ft. The average quantity of material excavated was 25.25 cu.yd. per linear-foot of canal.

At first the expectation was that teams would be used for excavating a base width of only 20 ft., leaving a 2½:1 slope and later using tractors or draglines to work the slope down to 1½:1. After the work was well under way, however, it was found possible to work the fresnos on the steep slope more effectively than had been expected; accordingly the plan was changed and most of the yardage was moved with fresnos.

An important factor in effective operation was the high quality of labor employed. The men were thoroughly experienced in handling teams and were willing to work hard. Coupled with this was an organization designed to get maximum efficiency. A sub-foreman over each ten-team group had instructions to keep the teams moving. He would relieve any driver for short intervals whenever occasion required; otherwise a driver's time was docked even for short stoppages. A general foreman on horseback was provided for each 100 or 125 teams. In warm weather there were two short recesses (without pay) as necessary rest periods for the teams in a 7½-hr. day. At other times the working day was a 6-hour period, which was about all the stock could stand on this heavy work. As excavation approached the steep slope of the finished canal the sides were cut down in benches, from which the fresnos hauled their loads up lesser slopes on runways established every few hundred feet. Material in the runways was the last to be taken out in cleaning up the canal section.

TYPICAL VIEW in a branch of the All-American Canal construction, where 900 head of stock hauled Fresnos.

About ten Fresnos were assigned to each 500 lin.-ft. of canal, and maximum progress was about ½ mile of practically complete canal excavation per week. Work began in October and was finished about the end of January, after which the crews were moved to a section east of Calexico that was expected to keep them busy until April 1. That date should mark the beginning of warm weather, after which work would be less efficient, and by that time the need for emergency relief was expected to have passed.

The teams did their most effective work at that stage of construction in which material from borrowpits on either side of the main canal was being brought to the banks. At this stage the teams made round-trips with four loads per trip. That is, starting from the center of the canal excavation, a load was taken to one bank, thence the team went to the borrowpit and brought back a load to the bank, then crossed the canal, taking a load from the bottom to the opposite bank, and finally completed the cycle by bringing a load from the opposite borrowpit to the embankment.

Most of the work could not be arranged on so effective a program, of course, and in certain districts the stock could not work at all where surface crust was sharp enough to cut through the skin above their hoofs. In sections where the crust was bad or the material was wet tractor-drawn scrapers were used for removing the first two layers of earth, after which teams and Fresnos were effective in completing the job.

All plowing and some of the scraper work was done with tractors, of which there were sixteen on the job; it was found that one tractor-drawn gang plow would just about keep ahead of 25 scraper teams. Tractors hauled gang plows equipped with four 10-in. or three 12-in. plow shares or were used on 4-cu.yd. dump scrapers. The rate of pay for the tractors and scrapers ranged from $3.30 to $3.80 per hour, depending on size, this to include driver's time and all costs of his equipment, such as supplies, materials, repairs, upkeep, etc. The pay for a team of four horses or mules with driver was $1.13 per hour, made up of 50c. for the man, 15c. for each head of stock and 3c. for rental and maintenance of equipment.

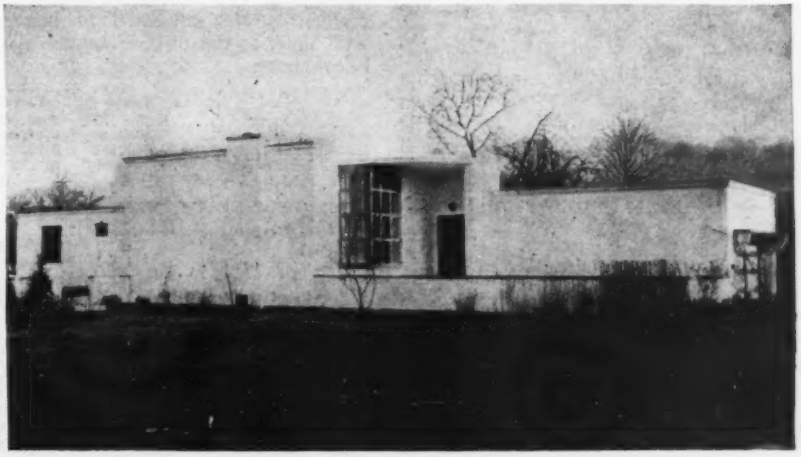
On this program of combined team and tractor operation and at the rate mentioned, the average field cost in the 7 miles of canal to December 31, was about 16c. per cu.yd. of material excavated. This is believed to be considerably more than the cost would have been by using mechanical equipment exclusively, but the plan of construction followed gave work to the large number of farmers who, with their teams, would have remained unemployed had this relief not been offered.

The work is under general direction of the U. S. Bureau of Reclamation, with R. B. Williams as construction engineer (Yuma); J. H. Fertig was division engineer (Calexico), and Frank B. Higley was superintendent of force-account operations.

Standardized-Room-Unit Plan Used in New Experimental House

AN EXPERIMENTAL HOUSE of modern architecture has been built by the General Electric Co. at Nela Park, Cleveland, Ohio, to test the value and practicability of a standardized-room-unit method of residential construction. The purpose of the experiment was to determine if such a method of design would permit a relatively low cost of construction and at the same time make it possible to equip the house with many new labor-saving and convenience devices; also to ascertain if such structures could perhaps be produced on a mass production basis. The fundamental concept of the plan is that a central unit,

STANDARDIZED-ROOM-UNIT HOUSE recently opened in Cleveland. The garage is in front of the base unit of living room, dining room and kitchen shown in the center with somewhat higher roof, and the unit of three bedrooms and two baths is attached to the rear of the base unit.



made up of a living unit, dining room and kitchen, be used with different units of sleeping quarters, to give from one to five bedrooms, each of these units being standardized in arrangement and construction. The house was planned and built by T. W. Frech, formerly vice-president and manager of the General Electric's incandescent lamp department.

Following several years of study Mr. Frech determined that there are a number of essentials bearing on more standardized and therefore lower-cost houses. Most important is the acceptance by the public of a lesser variety of floor plans. Second is the realization by the public that there can be beauty in uniformity. Third, there must be the abandonment of certain traditional high-cost forms of construction, such as the gable roof and the backyard location of the garage. Fourth, better planning must decrease waste space and increase the convenience of use. And fifth, new building materials must be developed. However, the latter is visualized as a difficult objective to be obtained in a short time.

As developed, plans for the standardized-room-unit house include the following: unit No. 1 (base unit), consisting of living room, dining room, kitchen and utility space, with the garage in front; unit No. 2, consisting of two bedrooms and two baths on the first floor, appended to the rear of unit No. 1; unit No. 3, consisting of three bedrooms, two baths, a dressing room and a mothproof storage closet, also appended to the rear of unit No. 1; unit No. 4, including one bedroom, one bath and storage space on the second floor above the dining room, kitchen and utility room; and unit No. 5, made by adding a bedroom to unit No. 4, placing it over a portion of the garage.

The Nela Park house is a combination of base unit No. 1 and unit No. 3. The exterior walls are of light-weight concrete blocks, 12 in. thick in the basement and 8 in. elsewhere. The exterior surface is covered with three coats of portland cement stucco. On the interior surface are fastened wood furring strips carrying rock lath with aluminum-foil insulating surface and two coats of plaster. Floors and roof are constructed with 2x12-in. wood joists. The first floor has a single thickness pine floor. The roof is surfaced with a four-ply tar and gravel roofing, and all roofs are protected with 4 in. of mineral wool fill as insulation. Much modern built-in equipment is utilized, as well as electric dishwashers, ranges and refrigerators.

Hays & Simpson, of Cleveland, were the architects, and Keyes-Truehaft, Cleveland, were the builders.

Variations in Thermal-Expansion Coefficients of Portland Cements

By S. L. Myers
Chief Chemist, Southwestern Portland Cement Co., El Paso, Texas

MOST INVESTIGATORS who have made studies of the thermal expansion of portland cement and its products have found the thermal coefficient of concrete to be about 0.0000055 and of neat cement about 0.0000080 per degree F. While the coefficient of concrete varies with the kind of aggregate, richness of mix and quantity of water used, and to a small extent with the storage conditions following hardening, the coefficient 0.0000055 is reasonably close to an average. Hardened neat cement, however, usually has a coefficient considerably above 0.0000080, and the low figures previously given by investigators may be due to shrinkage during the test. If a neat cement or concrete specimen is not protected by an air-tight cover while under test, shrinkage will occur due to loss of moisture, unless the humidity of the air approaches 100 per cent; even in the latter case, if higher than normal atmospheric temperatures are used, shrinkage will occur. Neat cements are more sensitive to this condition than mortars or concrete.

In some recent tests to determine the effect of composition and storage conditions on the coefficient for cement, all specimens were 1 in. square by 13½ in. long, sealed in thin copper foil which did not restrain the expansive movement of the test bar. The expansion and contraction of the test piece was measured by an Invar micrometer, using a microampere current to register contact: readings could be duplicated to the nearest 0.0001 in.

According to the accompanying tabulation, the thermal coefficient of expansion appears to increase in the following order: dicalcium silicate, tricalcium aluminate, tetra calcium alumino ferrite, tricalcium silicate, the latter having more than twice the value of the first-named coefficient. The coefficients also appeared to increase with time, as the three examples given below show:

	3 days	1 week
Standard cement.....	0.0000072	0.0000079
High-silica cement.....	0.0000066	0.0000068
High-lime cement.....	0.0000101	0.0000103

THERMAL COEFFICIENTS OF EXPANSION FOR NEAT CEMENTS

	Per Cent Cement Minerals				
	C_4AF	C_3A	C_2S	C_3S	Coefficient
Gamma dicalcium silicate.....	.....	.....	98.0	.....	0.0000052
Hi tricalcium aluminate.....	4.13	32.10	0	57.75	0.0000068
Tetra calcium alumino ferrite.....	99.0	.....	.....	.....	0.0000063
Standard cement.....	8.80	9.20	15.0	58.0	0.0000093
High silica.....	5.65	5.58	46.85	34.86	0.0000078
High early strength.....	10.50	12.00	3.60	66.23	0.0000108
White cement.....	1.40	12.50	41.50	33.00	0.0000104
High iron, High C_3S.....	18.24	3.83	6.49	68.79	0.0000092
Low tricalcium silicate.....	5.53	3.49	54.51	28.89	0.0000073
High tricalcium silicate.....	7.97	8.81	5.75	69.34	0.0000116
High silica, low R_2O_3.....	5.17	3.68	50.75	33.25	0.0000097
Very high C_3S.....	7.90	8.89	4.17	70.62	0.0000118
High R_2O_3, low lime.....	22.71	14.54	56.00	0.0	0.0000054

	1 month	6 months	9 months
Standard...	0.0000103	0.0000108	0.0000118
High-silica...	0.0000081	0.0000099	0.0000099
High-lime...	0.0000106	0.0000107	0.0000109

The increase of coefficient with time appears to be associated with the moisture condition of the neat bars, because the coefficient of bars having a high coefficient at nine months is lowered to values approaching the coefficient in early periods upon soaking the bar in water for a few days. Also, if the neat cement bars are stored in a dry atmosphere, their coefficient is increased, as indicated by the following example for standard cement:

Average 9 months.....	0.0000093
In $CaCl_2$ dessicator 1 week.....	0.0000080
In steam 1 week.....	0.0000066

In the case of steam treatment, low-coefficient cements are only slightly lowered, while cements with a high coefficient are lowered into the same coefficient range as low-lime or higher-acid cements.

The drying out of neat cement bars with age may have been due to the slow escape of moisture through the copper envelope, or it may be due to absorption of free moisture by the hydrating grains of cement. In making a bar of neat cement for these tests, all pastes were brought to normal consistency, with very little more water than is required for hydration.

That the thermal coefficient of neat cement, and to a lesser degree of concrete, varies with age and storage conditions fits in with the view that the concrete cement paste after hardening contains a network of capillaries, where there is a direct relation between capillary diameters, the hygrometric state of the air and the tension exerted on the capillary walls. Freyssinet has shown that these capillary tensions correlate the phenomena of plastic flow, shrinkage and thermal expansion.

Railway Engineers Resume Three-Day Meeting at Chicago

American Railway Engineering Association returns to practice of holding three-day annual meeting after limiting sessions to two days for four years—National Railway Appliances Association resumes its railway show after a lapse of a like period

A MORE HOPEFUL outlook on the part of the railroads and their closely allied industries is indicated by the expansion this year of the program of the American Railway Engineering Association from the two-day session that has been held during the past four years and the resumption of the railway show of the National Railway Appliances Association. The two organizations met concurrently in Chicago, March 12-14 and 11-14.

Changes in the status of the A.R.E.A. resulting from the formation of the Association of American Railroads were reported to the association at its opening session by John E. Armstrong, president, and E. H. Fritch, secretary. As was the case in its relation to the former American Railroad Association, the A.R.E.A. maintains its own identity under the new relationship, but its committees function also as committees of the department of operations and maintenance of the A.A.R., and the A.A.R. contributes to A.R.E.A. research work and administrative expenses.

Mr. J. Gormley, executive assistant to the president of the A.A.R., addressed the association on Wednesday, outlining its work briefly and commenting upon present problems of the railroads.

Financially, the association is in good shape, receipts for the year 1934 exceeding disbursements by $3,800. The net loss in membership was 125, the total standing at 1,903 as of March 1. Present at the meeting were 619 members and 299 guests.

New responsibilities

Three significant things from the viewpoint of the association have happened since the last meeting, said John E. Armstrong, president, in his opening address: "The Association of American Railroads has been formed; there has been a further awakening to the fact that there is a transportation problem of which the railway problem is but a part; and both the average and the maximum speed of railway transportation have been increased." For the new association, Mr. Armstrong asked the fullest cooperation and pointed out that the A.R.E.A. may have to change details of its organization to make it of most service to the new association.

Turning to the work of the A.R.E.A., Mr. Armstrong said that the present transportation problem calls for information of an engineering nature that is not now available, including the actual total cost of providing, conducting and maintaining the various forms of transportation; also the relative economy of each type of service required on any given case. A start in collecting this information has been made, he said, but no organization or collaborating group is prepared to state all the facts. The A.R.E.A., he added, is in a position to develop these facts in so far as they apply to railroad transportation and must be prepared to consider critically the corresponding presentations of other forms of transportation, or, if necessary, to prepare such presentations if they are not otherwise made available.

Higher speeds

Increased speeds, Mr. Armstrong said, are opening up new vistas for engineering research. "The railway industry is entering upon a period of evolution which in the magnitude and in speed of accomplishment should surpass that of the past 35 years of highway transportation. The railway engineer has before him as wide a field for research and improvement as the highway and automotive engineers had at the beginning of the century. If he is to make the most of his opportunity, he must press on with his studies for improving railroad transportation and reducing its cost. He must solve immediate problems, must anticipate and solve impending problems and at all times must be forearmed with facts and prepared to act promptly as occasion demands."

As long as the A.R.E.A. is the most efficient agency for securing required engineering information, it will continue to prosper, Mr. Armstrong said. It must keep abreast of the industry that it serves and must lead and direct the engineering thought and action of that industry. To that end, he recommended:

1. That the organization and methods of procedure of the association be surveyed with a view to making desirable changes to improve its service.
2. That in the light of present and prospective demands upon the association the entire field of railway engineering and maintenance be subdivided anew and each part assigned to an appropriate committee.
3. That present committees be retained, merged or disbanded as required by this new partitioning.
4. That the resulting committees be organized to handle regular or special assignments with the greatest possible dispatch.
5. That the manual be revised and rearranged for more efficient uses.

Railroad economics

Twenty-eight standing and special committees submitted extensive reports, all of which had been preprinted in bulletins of the association and distributed to the members. The first report to stir up active discussion was that of the committee on the economics of railway operation whose report on the coordination of facilities was subject to criticism for apparent failure to make provision for the capital represented by the abandoned facilities in the coordinated operations described. Question also was raised as to whether such abandonment did not adversely affect the mortgage of the railroad which abandoned part of its line in the consolidation.

Pointing to the need of covering all the questions raised in the difficult subject of consolidating the operations of separately controlled railroads, R. H. Ford, incoming president of the association, recommended to the committee that its study be extended to cover the apportionment of the Minneapolis and St. Louis Railroad among several roads. The committee also was requested to see whether there was any precedent for making an allowance for the value of a strategic position. C. A. Wilson said that the I.C.C. has not permitted a value to be so placed since about 1908 and yet it stood as one of the major obstacles to consolidation.

The declining ratio of man-hours for current repairs in relation to the period 1916-17 was clearly shown in the report of the committee on the economics of railway labor in the continuation of its study of the Lehigh Valley Railroad, but the committee did not attempt to distinguish between the effect of increased mechanization of maintenance operations and adverse financial conditions.

Track gangs

Of special value was the report of the railway labor committee on gang organization for maintenance work, a report that was devoted to surfacing work in which pneumatic tampers are used. Cost figures are given in the report, and diagrams are used to illustrate the distribution of tools and equipment. The data cover gangs of several sizes.

Ruling grades

After a long study of the relative merits of ruling grades lighter than 0.4 per cent in the light of modern operating requirements, also of the relative merits of increasing tonnage by the reduction of grades or by the construction of locomotives with greater tractive

power, the committee on the economics of railway location has found it impossible to lay down definite rules that are generally applicable. The economic limit beyond which grade reduction cannot be carried without introduction of new factors, such as starting resistance, is thought to be about 0.2 per cent.

Rail welding

Information that welders should have who are employed in building up the ends of battered rails is included in the report of the committee on maintenance-of-way work equipment. The same report gives information on oxy-acetylene and electric-arc welding, also on precision instruments that have been developed to measure rail-end batter and to facilitate the work of building up battered rail ends.

Complete track

A new committee to report this year was the special committee on complete roadway and track structure. Its purpose is not to develop new standards but rather to study the standards developed by the several standing committees to determine whether it is possible to assemble standards from them for a complete track structure to meet several different requirements. The committee announced that it expects to build its study around the three basic rail sections of the association; 90-lb., 112-lb., and 131-lb. R.E. sections. The committee's work is expected in part to answer the frequently voiced criticism of the association committees for failure to coordinate their activities.

Track stresses

Arthur N. Talbot reported briefly on the work of the track stress committee, which has been carried on jointly for many years by the A.R.E.A., the Am. Soc. C.E. and the A.R.A. (now A.A.R.). The major activity this year has been a study of the design of the joint bar for rail joints together with an examination of certain patent claims. Dr. Talbot reported that a subcommittee had joined with the committee on locomotive construction of the mechanical division of the A.A.R. in a further effort to show the need for a comprehensive investigation on locomotive counterbalancing and other vertical and lateral forces of the wheels of locomotives as well as the resulting reaction of track. This group's report is being held up awaiting a more favorable opportunity to recommend the expenditure of funds upon such a study, but it may be submitted to the A.A.R. soon, Dr. Talbot said.

Rails

Much interest was shown in the several elements of the rail committee report, and a long discussion centered around its report on the economic value of different sizes of rail, the committee's conclusion that increasing the weight of rail showed little increase in its value as an element of the track structure, being both sharply criticised and strongly supported. L. J. Hughes outlined a method that he has developed for putting a value on heavy rail which indicates that increased stiffness does not appear to be the most significant element in reducing maintenance costs, and W. C. Barrett said that the Lehigh Valley has found that its high rail has produced a real saving in track maintenance.

Dr. Talbot expressed the view that consideration of the subject on the basis of individual wheel loads (as the committee did) is misleading. He stressed the need for putting such theoretical studies as this committee has made to field tests.

The committee reported that in November the A.A.R. car for the detection of transverse fissures in rails had completed its sixth year of operation and now has tested 28,000 track-miles or 56,000 miles of rail. During the year a tow car has been put into service, designed to eliminate the difficulties experienced heretofore in towing the detector car, and the detecting equipment has been transferred to a new and larger car.

The rail committee drew attention to the fact that for the first time this past year the number of fissured rails detected by the cars now in service exceeded the number that were found through track failures. Though the total number continues to increase annually, the number found through track failures, has been decreasing since 1929.

As to rail failures, the annual statistics of failures in five years' service show that rails rolled in 1928 averaged 76.4 failures per 100 miles of track in 1933, a decrease of 36 below those of the 1927 rails in 1932 (112.4). This 1928 rate is the lowest figure yet recorded, with the exception of 74 failures per 100 miles for the rails rolled in 1914. Transverse-fissure failures numbered 9,124 in 1933, an increase of 2,070 over the number for 1932. The accumulated total of transverse-fissure failures to Dec. 31, 1933, is 74,405.

Progress on the joint investigation of mill practice and manufacture as they affect rail quality and rail failure, now entering its fifth and last year, was outlined in a brief formal statement by the rail committee. The program for the coming year is as follows:

1. Reduction of data of wheel-load tests and further field tests for wheel loads.
2. Completion of tests of thermally-treated rails and reduction of data.
3. Further tests of specimens of steel from various rail heads, including physical, metallographic and chemical tests.
4. Completion of tests and reduction of data for steel tested at low temperatures.
5. Summary of studies of rail-mill practice.
6. Summary of results of the search for non-destructive test for "shatter cracks," especially to see what suggestions may be made in connection with detection of fissures in service.
7. Summary of metallographic and chemical studies.
8. Preparation of formal report.

In an informal and "off-the-record" statement, Prof. H. F. Moore, of the University of Illinois, described the present work in considerable detail.

Track

Active discussion centered around the track committee report, especially its proposed changes in the tables for curve superelevation now in the association's manual. The differences of opinion were due chiefly to the fact that the superelevations proposed by the committee were grouped into three classifications: equilibrium speeds, comfortable speeds and permissible speeds. As to the latter table, it was stated on the floor that it was too conservative and might open the door to charges that railroads operating trains at higher speeds were overstepping safe limits. L. J. Hughes said that the formulas used were designed to keep the resultant within the middle third as is done in determining the resultant in foundation pressures. He said that limiting speeds ought to be figured for actual conditions to be met in track rather than in dams or buildings, and that extreme limits should then be set.

The committee chairman said that comfort rather than safe limits was the criterion toward which the committee worked.

The chairman's motion to substitute the tables for those in the manual was lost, and the tables were accepted as information only.

Steel railway bridges

Specifications for steel railway bridges for fixed spans not exceeding 400 ft. in length were offered by the committee on iron and steel structures, to replace the specifications now in the manual. The new specifications were attacked on several grounds, Meyer Hirschthal leading off with an attack on the live loading and impact formula proposed by the committee. He stated that there should be a modernized loading developed for all types of railroad structures. The impact formula, Mr. Hirschthal said, should distinguish between open-deck and ballast-deck bridges. Theodore Doll also took exception to the impact formula and said that it should contain a factor for speed. For bridges in towns where speeds must necessarily be slow, he said that a high impact value made the structure unduly costly. To this J. B. Hunley, of the committee, replied that the formula gives the maximum impact that can occur and called attention to the fact that the critical speed is not always a high speed and that it may be low for certain span lengths. He added that when the full report of the committee's studies is published it will show all the factors considered. Further, Mr.

Hunley pointed out that impact results obtained in a study of a partly loaded span may be quite misleading as to the effect on a fully loaded span.

Unit stresses in steel and in bearing on concrete as proposed in the specifications also were subjected to question, but point by point the committee won out on the voting, and ultimately the specifications were accepted substantially in the form submitted.

Bridge monographs

Appended to the iron and steel structures committee report is a series of monographs: "The Bearing Value of Rollers," by Wilbur W. Wilson; "The Change in Grade of Structural Steel," by A. W. Carpenter; "Comment on the Committee's Column Formula," by F. E. Turneaure; "Elastic Stability of Plates Subjected to Compression and Shear," by Otis E. Hovey; "Shears on Column Lacing," by Shortridge Hardesty; "Live Loads for Multiple Track Bridges," by A. C. Tammen; "Live Loads and Unit Stresses for Bridge Design," by Shortridge Hardesty; "Impact on Steel Railway Bridges," by J. B. Hunley; and "Net Section of Riveted Tension Members," by C. H. Chapin. These, together with the new bridge specifications, are published in Bulletin No. 374, A.R.E.A.

Timber

The committee on wooden bridges and trestles submitted general lumber and timber grading specifications that are in line with those favored by the U. S. Forest Products Laboratory and the manufacturers. As an aid to use and purchase, each grade has an identifying number that shows at a glance the fiber stress in bending or compression parallel to the grain, depending upon the use to which the lumber is to be put. The chairman said that almost identical specifications will be submitted to the A.S.T.M. in June, the two committees having cooperated in their work.

Masonry structures

The matter of divergent views on live-load specifications came up again when the masonry committee presented its report and Meyer Hirschthal, chairman of the latter committee, presented a motion calling upon the board of directors to appoint a committee representing the steel, wood and concrete groups to harmonize their views so that the association will have identical or at least harmonious loading requirements for each type of structure.

The masonry committee presented new specifications for premolded concrete piles and for driving them, for design loadings for railway masonry structures, and specifications for reinforced-concrete arches for railroad loading, all for inclusion in the manual. The specifications all were accepted for that purpose, with minor modifications in the pile-driving equipment specifications, resulting from a long discussion of the problems involved in driving heavy piles.

Methods and practices for lining railway tunnels with concrete, also proposed for inclusion in the manual, were the subject of active attack from the floor and ultimately were withdrawn from consideration for the manual this year. Tentative specifications for the use of liner plates also were submitted as information.

Shotcrete

Specifications for "shotcrete" were offered by the masonry committee in response to its assignment to "present specifications for pneumatically projected concrete or mortar." The term "shotcrete" was adopted by the committee for this type of material to avoid conflict with copyrighted names for materials falling within the general classification. The specifications were accepted for publication in the manual of the society.

Buildings

Recent developments in mill type and other wood construction for railway buildings were reported upon by the committee on buildings as a preliminary to the preparation of new specifications for such structures. Such matters as composite timber and concrete bridge decks and the use of ring and other types of connectors are covered. The same committee reported on various types of bus terminals, both isolated and in conjunction with railway stations.

Public improvement

A set of definitions of terms pertaining to public improvement projects was submitted by the committee on waterways and harbors, its chief object being to insure that all elements entering into the cost of such a project be considered in determining the economic justification for such projects. R. H. Ford, in presenting the definitions, said that both the Am.Soc.C.E. and the Western Society of Engineers had approved of them and that they had been used by the National Resources Board in its studies. The same committee submitted a form to facilitate the presentation of information as to the added costs involved in changing railroad structures to conform to the requirements of a new or enlarged waterway.

Wood preservation

Modernized specifications for part of the general specifications for creosote were presented by the committee on wood preservation, to be substituted for material now in the manual, thus bringing that material into accord with specifications prepared by the A.S.T.M. and A.W.P.A. The same committee submitted an extensive report on piling used for marine construction, some of it covering the ground covered in recent reports to the A.W.P.A. and the Am.Soc. C.E.

Railway Show

After a lapse of four years the National Railway Appliances Association resumed its show of railway maintenance-of-way and signal equipment at the Coliseum. Though not as extensive in floor area as were the displays of pre-depression days, the 1935 show covered a wide range of maintenance-of-way equipment and materials and clearly demonstrated the developments that have taken place in recent years.

The whole display served to emphasize the extent to which track-maintenance work has been mechanized and pointed to the need for studies such as the A.R.E.A. committee on the economics of railway labor is now making on the organization of labor gangs, using pneumatic or motor-driven equipment for track-maintenance operations. Exhibits of tractor-mounted earth-moving tools and cranes also served to show how recent developments in tractor mounting have made it possible for railway engineers to carry on many operations that formerly called for equipment mounted on railroad trucks. Tractor mountings of electric, gas and diesel power plants and air compressors for the operation of maintenance tools also were on display, another advance toward carrying forward those operations with a minimum of interference with train operation.

The mechanical track tools on display included tampers, spades, spike drivers and pullers, tie adzers, bolt tighteners, augers and bonding drills, also welders of various types for building up rail ends, and cutting and grinding tools for finishing the rails. The track tools were with and without self-contained power units, both large ones for gang use and small ones that can be handled by one or two men.

The largest single display was a complete turnout of "Geo" track, other large ones—in addition to the pneumatic and power-driven tools—included complete switches and crossing of cast-iron plates or composition steel and concrete plates. The latter show a tendency toward simplification and interchangeability of the units

Other track displays were rail joints and flange lubricators. Auxiliary displays include culvert and underdrain pipe, cribbing for retaining walls, corrugated liner plates for tunnel work, asphalt plank with coarse aggregate rolled into the surface, spray-painting devices, electric rivet heaters, pumps, pipe, stainless and corrosion-resisting steel for use in car bodies and in piping, and composite building materials. The hood of a large smoke jack, hung in realistic fashion from the under side of the gallery, showed clearly the progress that has been made in developing that most difficult detail of engine-house construction since the first ones of asbestos and cement composition board were made two decades or more ago.

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Dust and Water

A SHARP REMINDER of continuing drought conditions in the area between the Missouri and the Rockies speaks out of the reports of extensive dust storms in the Great Plains, which apparently were as heavy and far-reaching as those of a year ago. Local reports, moreover, tell of the absence of winter moisture in that region, and forecast with assurance that the 1934 experience of water shortage and crop failure will be repeated. It is already apparent that the pressure to reconsider and readjust land use in large parts of the Plains will be increased, and in all probability the westward movement of population that became emphatic last fall will acquire greater momentum. Under these circumstances effective water utilization, and in preparation for it a thorough study of water resources, becomes a prime necessity, both in the Plains region itself and in the irrigated West which must receive the emigrants. Conservation and development of the remaining western water resources therefore deserve to be taken in hand purposefully, with effective cooperation of all the regions concerned.

Individualists

IT IS STATED frequently that engineers are individualists, and, generally, the statement is not any too complimentary in its meaning. That characteristic again must have impressed itself upon any one who sat through the sessions of the American Railway Engineering Association in Chicago last week, for it stood out not only in the attitude of individuals but also in that of committees. Committees of the association insist on functioning as independent units, and frequently submit data for inclusion in the association's manual of approved practice that are in conflict with data already in the manual or being prepared by other committees. The resulting confusion on the part of the unwary user of the manual is apparent. Similar lack of logical group action can be found in other organizations. It raises the question whether this characteristic, this apparent inability to agree and to harmonize action, may be the reason why the public is reluctant to put engineers in administrative positions for which their training would appear to fit them. Is the engineering type of mind essentially individualistic? Does the logical analysis of facts fix conclusions so firmly as to make it abnormally difficult for an engineer to adjust his thinking to that of others? Or, perhaps, is our present system of training engineers deficient in those things that make for group action? Our impression is that both are in part responsible.

Railroad Research

NEW KNOWLEDGE of materials essential to railroad structures and equipment, new types of equipment and a demand for higher speeds and more modern facilities, open up to the railroad engineer vast possibilities for research into the use of materials and equipment. In another direction, the competition of newer forms of transportation calls for exhaustive research into railroad operating problems and for renewed study of the economic considerations that bear on those problems. This situation was recognized by John E. Armstrong in his presidential address to the American Railway Engineering Association, and the changing scene was used by him as background for an appeal for active research in the railway engineering field and especially for a concerted effort upon the part of the association to assemble and coordinate the facts that will be needed by railroad managements in meeting the demands of changed conditions. The latter is especially desirable. Obviously, railroad engineers cannot be expected under present conditions to undertake extensive field or laboratory research; but they can contribute toward solving the present problems of the railroads through early appreciation of what facts will be needed for the solution of those problems and by prompt assembly and analysis of such facts as are available. They must also be prepared to point out where facts are lacking and to indicate where best they can be obtained. Here is no easy task. It calls for vision and sound thinking unhampered by past traditions.

The Purpose of the Works Bill

WHILE CONGRESS is debating the works bill the real function of the gigantic appropriation measure is in danger of being forgotten. Cities, states, federal departments and various local interests look anxiously to the new fund and expect it to help them out of their individual troubles. They regard it as the great and sole means of recovery, as an agency destined to lighten their tax burdens and bring new customers to their doors. They overlook the essential character of the problem which the new bill is designed to meet and forget that federal works can provide only a starting push, which without their vigorous efforts at self-help is bound to remain without lasting effect. It ought to be remembered that only 3½ million men are to be given work under the plan of the bill, and that two-thirds of these are already engaged in work relief. Two or three times as many will still need employment, not in public construction but in factory, store and office where they formerly were employed. Even the utmost ingenuity in allocating the fund to a great variety of applications cannot succeed in supplying either the amount or the kind of work needed to do the whole job; that must be done by the cooperation of private business. Thus, while the task of administering the bill is sure to be one of serious difficulty, industry and business have an even more serious task—to put the full resource of initiative and self-help back of the impulse produced by the bill, in order that recovery and revival shall reach everyone and become enduring. That is the ultimate purpose of the emergency works plan.

Wood-Reinforced Concrete

RUSSIAN BRIDGE CONSTRUCTION makes an interesting contribution to engineering method with its wood-reinforced concrete caissons, described on another page. Theoretically, the want of dependable tensile strength in concrete may be supplied by wood as well as steel, if due allowance is made in the stress factors assumed. But in practice the bulkiness of wood tension elements

and the difficulty of adapting the material to the bent forms that are desirable render it a clumsy material for the purpose. In Russia steel is scarce while wood is plentiful and cheap, and these facts doubtless were the compelling factors in developing this novel type of reinforcement. The foundation caisson afforded also the type of structure providing inherently the greatest possibilities for new adventures in reinforcement. Fundamentally the caisson is ordinarily a resource of construction rather than a self-sufficient element of structure. With strength and stability to carry safely to the foundation bed its essential purpose is completed. In Russian practice wood reinforcement has proved adequate for the main construction purpose of the caisson. This is enough justification for its use, particularly where steel is a vital necessity for more important parts of structure, and generally under any condition where economy is gained without loss of essential structural purpose. Russian engineers are to be credited with an addition to the resources of engineering by their proof of the practicability of wood reinforcement of concrete in special instances such as the one under discussion.

Not for the Public Good

BY PAYING road-service charges in the form of fuel taxes and operating fees the motor vehicle owners of the United States have made possible the development of a group of highway administrative organizations that in efficiency and rectitude have never been surpassed in governmental experience. The state highway departments, as well as the road organizations of many progressive counties, have accomplished highly meritorious work in improving our basic transportation system and in so coordinating its units that freedom of communication is not mere theory but actual present day fact. Today they are more necessary and more important agencies of public service than at any previous time, yet they are under imminent threat of destruction by diversion of their funds. To permit such destruction, to allow our transportation plant to deteriorate, and to commit the wanton injustice of taxing one industry for the private benefit of others, is directly opposed to the public interest.

More is at issue than merely a halt in road improvement. The present proposal to impound highway service charges for general expenditures is a fundamental threat to the principle of administering public service agencies on a self-supporting, equitable basis.

The same threat is hanging over city water departments, transportation systems, and other autonomous organizations of the public service. These too are having their revenues, needed for future development and improvement, and often indeed their revenues for current operation, brazenly appropriated by local government authorities, to meet general expenditures not connected with the services in question.

Relief doles, on the one hand and the demands of less provident departments of the government on the other, constitute the readiest present excuses for such diversion, though the unmistakable reason in most instances is a dishonest desire to place undue burdens on one part of the population for the advantage of another part. Whatever the motive, however, the result is to destroy all incentive to sound and efficient business management, and to relegate public service administration to the devious trails of political intrigue and log-rolling as the sole means of obtaining urgently needed funds for development of the service. No single governmental policy of today is more questionable, none is more subversive to the continuance of honest and efficient public works management, than the widespread diversion of revenue funds that is being practiced today.

Most imminent is the danger in the field of road administration. State legislatures in some instances have grown so bold that from mere diversion of road service revenues they are proceeding to confiscation. Prominent current examples are found in New Jersey and Pennsylvania. Pennsylvania not only proposes to impound $100,000,000 of road money—virtually all of the receipts for two years—but, adding insult to injury, proposes to lay a further tax on the robbed road user by increasing the gasoline tax rate 2c. a gallon, a levy that will draw another $40,000,000 from the pockets of those who travel Pennsylvania roads during the next two years. And what of Pennsylvania's highways? They have too long been the "sacred cow," say the legislators; and besides, federal contributions are expected to take care of road improvement!

New Jersey's legislators are somewhat less specific. They have contented themselves with saying that they want about $10,000,000 of road funds. Though the Governor is courageously opposing this demand, the members of the legislature disregard his views. And when the state highway engineer laid before them the plain truth that this would wreck the department and let the transportation system of the state go to wrack and ruin, the solons were little impressed; their only concern was to avoid the embarrassing task of asking the taxpayers to provide dole money, regardless of how they would add to unemployment by their procedure.

Such examples of legislative thinking have deep meaning for the public, whose welfare is at stake and whose patiently accumulated assets are in jeopardy. But they are no less significant to the highway construction industry, which is bound to admit that it is placed under indictment by these current events. The industry on which our transportation system depends, and which in turn depends upon it, has singularly failed to sell its service to the public. Even today that industry is supporting only reluctantly the few organizations that are fighting to maintain highway development, and because of lack of support these organizations are uncoordinated and lacking in the strength of concerted effort. Until the industry can rouse itself to joint thinking, and translate this thinking into purpose and action, its mission of developing road-building and transportation will continue to be attacked by self-interest.

We repeat that road revenue diversion does not stand alone. Survival of the whole system of efficient, self-sustaining public service is at issue. The extent to which water funds have already been depleted and the necessary safeguarding of supplies interfered with is widely known. Whoever is concerned in preserving the efficiency and integrity of public administration, then, can serve the public welfare by raising his hand against the current attacks on highway revenues.

CURRENT NEWS

Works Bill Amended To Extend the PWA For Two Years

(Washington Correspondence)

AN AMENDMENT to the Administration's $4,880,000,000 work relief measure for extending the PWA for an additional two years was passed by a viva voce vote in the Senate on March 18. The extension of the life of the PWA organization is intended to permit it to complete the original $3,300,000,000 public works program. Under the amendment the PWA would continue until July 1, 1937.

On Tuesday, March 19, the Senate overwhelmingly defeated the proposal of Senator Byrd to reduce the total appropriation to $1,880,000,000 by a vote of 66 to 21 and an amendment offered by Senator Adams to reduce the appropriation to $2,880,000,000 was defeated 57 to 30.

Prevailing wage defeated

Defeat of the McCarran prevailing wage amendment removed the largest hurdle faced by the measure. Prevailing wage rates must be paid on all federal building projects in accordance with the Bacon-Davis Act but the Russell amendment, as adopted by the Senate, empowers the President to fix wage rates on all other types of projects that, in his judgment, will not pull down going rates for work of a similar nature. The Russell amendment applies to projects financed by government loans as well as to projects which represent a direct expenditure. The text of the amendment which finally broke the deadlock in the Senate, reads:

The President shall require to be paid such rates of pay for all persons engaged upon any project financed in whole or in part, through loans or otherwise, by funds appropriated by this joint resolution, as will, in the discretion of the President, accomplish the purposes of this act, and not affect adversely or otherwise tend to decrease the going rates of wages paid for work of a similar nature.

The President may fix different rates of wages for various types of work on any project, which rates need not be uniform throughout the United States: *Provided, however,* That whenever permanent buildings for the use of any department of the Government of the United States, or the District of Columbia, are to be constructed by funds appropriated by this joint resolution for which rates of wages are now determined in accordance with the provisions of any law of the United States or any code, the President shall fix the rate of wages upon such public buildings in accordance with such laws and codes.

Relief money shrinking

The $880,000,000 which the works bill appropriates for direct relief from unexpended balances of PWA and other funds has already shrunk to $625,000,000 and will continue to diminish as FERA draws on this impounded money to meet direct relief requirements. This is significant as the work relief bill permits the President to draw on the $4,000,000,000 appropriated for the work program if more funds are needed for direct relief.

Department of Public Works Proposed by National Society

Establishment of a Department of Public Works in the federal government and the addition of a Secretary of Public Works to the President's cabinet, is to be the object of a campaign by the National Society of Professional Engineers, according to an announcement made by D. B. Steinman, president of the society at the annual meeting of the New Jersey Association of Professional Engineers held in Newark on March 16. A like proposal was put before the New York State Society of Professional Engineers at its winter meeting held in Albany on March 2. At that time a resolution was adopted calling upon the national society to promote the appointment of a professional engineer to the position of Secretary of Public Works.

Similar proposals have been made in the past. Most recently the Cochran bill was introduced into Congress in 1932 with the endorsement of American Engineering Council. It called for establishment of an "Administration of Public Works" to direct and coordinate the public works construction of the federal government. The administrator was not of cabinet rank but was to be appointed by the President for a 15-year term. He was to be qualified to "evaluate the technical principles and operations involved in the work thereof." In 1926 a committee of Engineering Council reported upon the establishment of a Department of Public Works and Domain, and at the following session of Congress a bill was introduced proposing to set up such a department to include the principal construction operations of the several federal departments.

Canada Studies Possibility of National Housing Program

A program for national housing development is being studied by a special committee of the Canadian House of Commons. This committee has received exhaustive reports on the need for slum-clearance and low-cost housing replacement in the cities of Halifax, Montreal, Toronto, Winnipeg and Vancouver. Opinion indicates that the committee will probably recommend a program for state-aided housing for the lowest income groups. Such a program might be accompanied by an effort to stimulate private enterprise by establishing a form of credit for the renovation of existing houses and the construction of new homes by those in higher income groups.

According to an analysis made by the Bank of Nova Scotia, there exists a backlog of $300,000,000 in residential construction.

Federal Housing Advances Toward Construction Stage

TWO more slum clearance housing projects were put up for bids by the PWA during the week, bringing the total of "construction stage" projects to four. The new projects are those at Cleveland, Ohio, and Montgomery, Ala. A contract will be awarded shortly for the University project in Atlanta, and construction is under way on the Techwood project in Atlanta.

Cleveland was one of the first cities to attempt a large scale slum clearance project but the deluge of difficulties encountered has taken nearly 2½ years to subside. Bids invited for April 23 cover the construction of apartment buildings for 654 families and other structures on an 18-acre plot of slum-cleared land. The PWA allotment for the work was $3,044,000. Walter P. McCornack of Cleveland is the architect.

Allotment of $2,400,000 for a project in Milwaukee to provide 529 family units on 33 acres of vacant land on the north side of the city was also announced. This project was approved once before but had to be temporarily abandoned when funds were withdrawn by the PWA.

In connection with federal housing, Horatio B. Hackett, director of the PWA housing division, reported last week that "more new living units for American families will be under construction during this year in the PWA's slum clearance and low rent housing program than there were new residential units built by the private building industry in the 364 principal towns and cities of the United States in either 1932 (30,697 units) or 1933 (28,424 units)."

In the meantime the National Public Housing Conference is urging new state laws, to enable the creation of local public housing authorities eligible to utilize a part of the $450,000,000 allotment in the new work-relief bill that has been earmarked for housing. It points out that 38 states are still without such legislation. The ten states which have public housing authority laws are New York, Delaware, Illinois, Kentucky, Maryland, Michigan, New Jersey, Ohio, South Carolina and West Virginia.

Colorado River Authority Plan Advanced in California and Utah

The creation of a Colorado River Authority to control the development and use of the river's water has been endorsed by representatives of six Southern California organizations interested in the project. A resolution was adopted calling on the California legislature to memorialize Congress and other Colorado River basin states to consider the establishment of such an authority to have general control of the river's water development and use. The Utah legislature, it also announced, has already memorialized Congress.

Spring Thaws and Rains Cause High Water In Several States of Mississippi Valley

USUAL spring thaws, accompanied by heavy rains, have resulted in damaging high water on several tributaries of the Mississippi River, with accompanying inundation of low areas and a temporary closing of highways. Levee breaks were reported on the St. Francis River near Kennett, Mo., and "flood stage" was experienced along the Ohio River. A report released by the U. S. Weather Bureau indicated that the possibility of general flood conditions could be discounted unless severe rains continued over the Mississippi valley states. Most tributaries were subsiding as this was written.

In the state of Mississippi, the Pearl River set a new high-water stage of 35.2 ft., with inundation of a five-mile area and interrupted highway use. This high water was due to local heavy rains and the river receded rapidly. Backwater on the Pearl River caused the Jackson Town Creek to flood a wide area in the capital of Mississippi, as shown in the accompanying illustration, requiring the evacuation of 300 families. In the Coldwater River basin the high water overflowed some lowlands. The Tallahatchee has been able to handle the water from its swollen creek tributaries.

St. Francis and White River

Heavy rainfall March 9, 10 and 11 in the Arkansas, White, St. Francis, lower Missouri and Ohio River basins, reaching a total of 7 in. over the upper White and St. Francis, has resulted in high flows in these streams. Although only moderately high stages are being experienced in the Mississippi River, very high floods are occurring on the White and St. Francis. The stages at St. Francis, Ark., on the St. Francis River, and Georgetown, Ark., on the White River, exceed 1927 crests. The flood had not yet reached the mouth of either of these tributaries on March 18.

Considerable lengths of the St. Francis levees have been overtopped, with consequent breaks which will overflow an area of 100,000 acres. A determined fight is being made by local forces assisted by relief labor and in full cooperation with War Department engineers. As many levees as possible will be held, and stock and people are being evacuated where necessary, according to a telegraphic report received from Brigadier-General H. B. Ferguson, president of the Mississippi River Commission at Vicksburg.

On the White River only four breaks had occurred to March 17, but as the flood advanced, the overtopping of additional levees was expected. No reliable data are yet available on damage and extent of areas overflowed.

In southern Illinois, 40 per cent of Saline County was reported under water, and several highways were put out of use. The Big Muddy was out of its banks at Murphysboro. Similar conditions occurred at several points along the Ohio River, with damage minor, and the river not expected to exceed normal flood stage.

BACKWATER from a flood on the Pearl River inundated a section of Jackson, Miss. (above) and high water on the Black River in Missouri (a tributary of the White River) resulted in overflow conditions in the town of Poplar Bluff (below)

Private Toll Tunnel Proposed Under Houston Ship Canal

A proposal for a privately owned toll tunnel under the ship channel at Houston, Texas, estimated to cost $2,500,000, has been formally accepted by the commissioners court of Harris County. The tunnel would be located two miles south of Lynchburg, Texas, and its primary purpose would be to shorten the highway distance between Houston and the tri-cities, Baytown, Pelly and Goose Creek, by seven miles. The plan was proposed by the engineering firm of Robert R. Livingston & Co., New York, calling for the construction of the tunnel without cost to the county in return for a franchise to operate it for 20 years as a toll project. The suggested toll would be 20 cents for each automobile passing through the tunnel. After the tunnel has been operated for 20 years, it would revert to the county.

Work on San Gabriel Dam No. 1 Postponed Three Months More

The Los Angeles county board of supervisors and representatives of the West Slope Construction Co., which is building San Gabriel Dam No. 1 for the county flood control district, on March 13 agreed on a further 90-day extension of the 120-day shut-down of work on the structure. Construction was stopped Nov. 14 to permit the flood control district to redesign the dam. In the new agreement the matter of costs and damages suffered by the contractors because of the shut-down is to be adjudged by a judge of the superior court without a jury.

Stimulation of Private Housing Is Difficult Task

(*Washington Correspondence*)

READY to unlimber a big drive to speed up home modernization, construction and financing, FHA Administrator Moffett told the President last week that only $250,000,000 had been spent on such work since last August. FHA's situation has been and still is desperate. In the face of the passive resistance of money lenders, Mr. Moffett has traveled up and down the country advertising the advantages to both borrower and lender of FHA's modernization credit and mortgage insurance plans. Bankers seem now to exhibit a slightly more cordial attitude toward the insured mortgage, although to date only 3,073 institutions have accepted the contract to provide home financing on FHA's terms.

Administrator Moffett has gained the backing of several life insurance companies for allocating funds to various districts throughout the country that, in the aggregate, may reach $2,000,000,000. FHA offices have received applications from present and would-be home owners for insuring about $7,000,000 to date. The figure is still so low that it hasn't been announced officially. Also there is some doubt as to what proportion of property owners who want refinancing can qualify for insurance of their mortgages even if lenders were found to accommodate them. Some part of this end of FHA's business seems destined to revert to HOLC under its new authorization from Congress to distribute $1,750,000,00 more in government credit.

One of FHA's big hurdles was state laws which prevented financial institutions from making loans up to 80 per cent of the appraised value which, coupled with insurance of such loans at moderate interest rates, is the keystone of the Housing Act. Appropriate enabling legislation now has been passed by 26 states. Similar bills are pending before 16 state legislatures now in session; special sessions will be called in Virginia, Kentucky and Mississippi and the Florida legislature will convene April 9.

A big cloud on the home building horizon is the earmarking of $450,000,000 for housing in the work relief bill. Protests have been presented to the President and to Congressmen by the retail lumber dealers that, with the new business now offering, the government should go no further into subsidizing cheap home building. They contend that private financing, backed by government insurance, will plug further drains on the United States Treasury and, at the same time, provide the unemployment relief sought by FERA and other agencies which have invaded the building field.

During the past week the RFC formed a mortgage discount company in Annapolis. It is said to have been organized to stimulate the formation of similar corporations by private interests as provided by Title III of the Housing Act; no such companies have yet been formed. In the meantime real estate interests continue to urge a federal mortgage discount system that would function along lines similar to the Federal Reserve.

R. H. Ford Elected President of Ry. Engineering Association

Robert H. Ford, assistant chief engineer, Chicago, Rock Island & Pacific Railway, Chicago, was elected president of the American Railway Engineering Association at its annual meeting held in Chicago, March 12-14. Mr. Ford succeeds John E. Armstrong, assistant chief engineer of the Canadian Pacific Railway.

Mr. Ford is a native of St. Albans, Vt., and a graduate of Norwich University in the Class of 1892. From 1892 to 1906 he was on roadway and bridge work on the Central Vermont Ry. and in 1906 went to the Missouri Pacific as an inspector in the maintenance of way department, subsequently becoming principal assistant engineer and assistant to the chief engineer.

Robert H. Ford

In 1910 Mr. Ford left railway service to become chief engineer of the Hodge-Downing Construction Co., general railway contractors at Birmingham, Ala., which position he held for two years.

Mr. Ford returned to railway service in 1912 to become special engineer, Rock Island Lines. Subsequently he was appointed engineer of track elevation, principal engineer, and assistant chief engineer. At the present time he is serving as chairman of the committee of engineers appointed by the president of the Association of American Railroads to advise the association on crossing elimination matters.

Other new officers elected were J. C. Irwin, second vice president, and Ralph Budd, Bernard Blum and W. T. Dorrance, directors. E. H. Fritch was reelected secretary and A. F. Blaess, treasurer.

E. H. Fritch honored

The formal proceedings were interrupted on Tuesday to felicitate E. H. Fritch, secretary of the association, upon having reached his 75th birthday. A bound volume of letters of congratulations was presented to Mr. Fritch by the association and the National Railway Appliances Association presented him with a large bouquet of flowers. Later at the luncheon meeting the Palmer House presented him a birthday cake.

A report of the technical proceedings of the A.R.E.A. meeting will be found on p. 425.

Data Released on Apprentice Training In Construction

INFORMATION on the recently-instituted program of apprentice training in the construction and other industries has been released by the Construction Code Authority. Under the provisions of an Executive Order issued by President Roosevelt, June 27, 1934, and a subsequent Administrative Order by the Secretary of Labor, there has been established a Federal Committee on Apprentice Training designed to coordinate a nation-wide program. Standards of observance have been set up and means provided whereby employers might contract with apprentices at less than the wage minima established in codes. Members of the federal committee are Carl M. Beyer, Department of Labor, Stanley F. Posner representing the National Recovery Administration, and Frank Cushman of Interior Department's Office of Education. Offices are in the Labor Department Building, Washington, D. C.

Certificate required

In order legitimately to employ an apprentice under a code, an employer must secure an Apprentice Exemption Certificate from a state committee on apprentice training. These committees are being established by the national office in cooperation with the NRA. Up to March 1 there had been 41 state committees approved, together with 26 state plans and copies of apprentice contracts or indentures established under the new system.

The program for every state in the nation cannot be entirely unified because of the varying state laws on apprentice training already in existence. However, where there are no state laws at present, it is being urged that state programs be developed along the lines of a recommended plan, to effect as great similarity and coherence as possible.

An apprentice is defined by the federal committee as a person of at least 16 years of age who has entered into a written contract with an employer or an association of employers which provides at least 2,000 hours of reasonably continuous employment for such person and which provides for his participation in an approved program of training.

Certificates of exemption permitting the employment of apprentices at less than code wages will be granted by a state committee only if the employer enters into a written contract with the apprentice and agrees to the following conditions:

1. The apprentice shall receive training for a stated number of years, not less than one or more than five.
2. The apprentice shall receive instruction in general and technical subjects for at least 144 hours per year.
3. The apprentice's hours of work and instruction, combined, shall not exceed 44 hours per week or the maximum hours fixed by the code for the industry.
4. The processes which apprentices are to learn and the actual wage scale must be stipulated in the apprentice's contract and approved by the state committee.

Each state program provides for the es-

tablishment of state and local trade advisory committees composed of an equal number of employer and employee representatives. The employer representatives are to be chosen by the industry's state association while the employees' representatives are to be selected by the organized labor group in the occupation. These advisory committees will be asked for recommendations on the number of apprentices to be trained, the prevailing journeyman rate and the percentage to be paid apprentices at the varying stages of training, the schedule of processes to be learned, the record and qualification of employers and the cancellation of contracts.

Realizing the importance of this coordinated apprentice training program, the National Construction Planning and Adjustment Board has appointed a committee to make a thorough study of the present apprentice conditions in the construction industry and to report its findings together with recommendations as to what is to be done in this regard when the demand for workers increases with recovery in construction.

Federal Government Will Not Appeal Slum Clearance Decision

The federal government has withdrawn its appeal to the U. S. Supreme Court from the decision of the federal district court at Louisville, Ky., which held that the federal government does not have authority to condemn private property for slum clearance. The government has decided to let the case come up through the U. S. Circuit Court of Appeals. In the Louisville case, the government sought to condemn four city blocks for the construction of a $1,618,000 project.

In the meantime, the Public Works Administration is carrying forward its low-cost housing projects elsewhere. Condemnation proceedings against four blocks in the Williamsburg section in Brooklyn were filed March 11 in the federal district court by the Department of Justice. The area named in the suit is bounded by Maujer St., Bushwick Ave., Ten Eyck St. and Leonard St. and is a part of a $12,500,000 project. Under the terms of an agreement with the city, the PWA is to obtain title to the land and lease the site to the Municipal Housing Auhority. The housing will be constructed with PWA loans and grants under joint supervision and control. About 25 per cent of the site had been acquired before court proceedings were resorted to.

Virginia A. S. C. E. Student Chapters to Hold Joint Meeting

The first joint meeting of the four student chapters of the American Society of Civil Engineers in Virginia will be held at the Virginia Military Institute, Lexington, Va., March 29 and 30. Sponsored by the Virginia Section of the parent organization, this meeting is the result of an effort to bring the student chapters closer to the national society. The plan is to make the meeting an annual affair, held in turn at each of the four institutions: Virginia Military Institute, Virginia Polytechnic Institute, University of Virginia, and Washington & Lee University.

Heavy Industries for Bonneville Power Recommended in Majority Report

TWO REPORTS, one signed by a majority of four, the other by a minority of three members of the Bonneville Commission of the State of Oregon, are bound in the recently printed report of that Commission relating to prospective uses of the power developed at the Bonneville project on the Columbia River near Portland. The commission of seven, appointed by Governor Meier of Oregon in accordance with a resolution of a special 1933 legislature, is headed by D. C. Henny, consulting engineer of Portland. Three members concurred with Mr. Henny in the majority report. The minority report is signed by John H. Lewis, former state engineer, and two attorneys.

The two reports diverge on the kind of use most likely to absorb Bonneville power and on the manner of distributing it. The majority report finds that the best chance of economic utilization lies in attracting heavy energy-consuming industries to the vicinity of the dam; the minority advocates state-wide distribution over state-owned transmission lines.

Majority report

The majority report defines the market area most likely to be affected by the Bonneville development and analyzes the power supply and use in that area, finding a substantial surplus capacity over present needs. In seeking economic uses, the report analyzes domestic and industrial possibilities and irrigation. In the domestic field it finds average annual use in the market area equals 1,110 kw.-hr. against the national average of 604 kw.-hr., and concludes that the domestic market does not offer a particularly promising field for the consumption of a large portion of Bonneville power unless means of working out house heating economically can be found.

In its discussion of house heating, the report finds two draw-backs leading to the conclusion that little confidence should be placed in the rapid utilization of electric energy for this purpose: (1) The extremely low price (below cost) at which the energy would have to be sold to compete with the existing fuels, and (2) the high price of present equipment for utilization. Low annual load factor of this load is shown to contribute to the cost of serving this business.

Heavy industries

The most promising field for economic utilization of Bonneville power is found to be in the heavy power-consuming industries such as metals, pulp and paper, and chemicals. The existence of raw materials, tide water transportation at the dam site, and other favorable factors are balanced against distance from prospective markets for the finished product and other unfavorable factors in the discussion of prospective uses in these three major industries. From this analysis the report found that the greatest possibilities appeared to exist in the development of aluminum, aluminum alloys, iron and steel, ferro alloys, high grade spruce pulp products, and various chemicals and fertilizers.

The report recommended that the Federal government be urged to construct a transmission line from Bonneville to Portland and to announce as soon as possible promotional rates necessary to attract heavy industries. It further recommended that

ALL-AMERICAN CANAL WORK GOES FORWARD THROUGH DESERT SAND

ON a 30-mile section of the All-American Canal project which is now under contract, excavating equipment has moved 3,000,000 cu.yd. of material, to date, with 1,128,000 cu.yd. handled during the month of February. When completed, the 80 miles of main canal will provide an improved conduit for the irrigation supply of the Colorado River to the Imperial Valley in the southeastern corner of California. The general features of the project were reviewed in *ENR*, Oct. 18, 1934, p. 488, and a description of some of the operations which are being carried out by force account is contained in this issue.

The project is part of the Boulder Dam project and is being carried out by the Bureau of Reclamation for the Imperial Irrigation District under contract to repay the cost of construction to the federal government. Construction work started in June, 1934. The total cost is $38,500,000. Most of the excavation is through desert sand with a short section in rock.

The present contracts cover a 30 mile section beginning 4¼ miles below ultimate point of diversion. Six schedules totalling 39,389,000 cu.yd. of common excavation were awarded to W. E. Callahan, H. Gunther and J. P. Shirley at a contract price of $4,859,587. One schedule of rock excavation, amounting to about 500,000 cu.yd., was awarded to the John Griffiths Co. at $226,800.

the state investigate (1) resources for manufacturing processes likely to be established; (2) the methods and policies by which the benefits of cheap Bonneville power may be realized to their fullest extent, including increased domestic uses; (3) the method of transmission and distribution and the extent such undertakings should be financed and built by the United States, the state of Oregon, or by existing utilities.

Minority report

The minority report reached the conclusion that the largest potential market for Bonneville power is in the homes and farms of Oregon, and that the next largest market is in the light industry widely scattered throughout the state. It concurred with the majority report that a very important future market is in the heavy electric base industries and chemicals. The report advocated a state owned and operated transmission network covering the entire state, and an interstate network constructed by the federal government.

Its recommendations were all directed to the 1935 session of the Oregon legislature just convening at the time the report was published. The legislature was asked: (1) to petition the United States government to construct an interstate power transmission system connecting all public and private plants in the Northwest; (2) to create an elective state power commission to prepare a plan for development of transmission and distribution of power; (3) to adopt a plan for state-wide power transmission, showing on a map the lines to be constructed and designating their order of importance; and (4) to petition the United States to charge not less than 50 per cent of the cost of the Bonneville development to navigation, deferring amortization of the cost of the power part of the project for 50 years.

Further study recommended

Following the issuance of the report, a sub-committee of the Oregon Planning Council, affiliated with the National Resources Board, considered the divergent views of the majority and minority report and passed a resolution recommending further surveys, investigations and studies to determine the most economic and beneficial means of distributing Bonneville power, and further studies of the most beneficial uses of this power. The resolution asked further that this investigation include a study of the feasibility of constructing interstate transmission lines connecting the chief industrial centers of the Pacific and the Northwest.

Tunnel Work Injunction Request Dismissed by Federal Court

The United States District Court at Los Angeles has granted a motion of counsel for the Metropolitan Water District of Southern California to dismiss an application for an injunction asked by the Wenzel and Henoch Construction Co. The company filed a petition for an injunction last month when the district revoked its contract on the San Jacinto tunnel project on the grounds that the company was not proceeding rapidly enough with the work. After revoking the contract, the district moved in its own forces and continued the tunnel construction.

Campaign for Funds to Continue Engineering Index, Inc.

A campaign to raise a working capital of $160,000 for Engineering Index, Inc., has been started by a committee headed by Frank B. Jewett, president of Bell Telephone Laboratories, Inc. The movement to save this fifty-year-old index and annotating service of the engineering profession is headed by Colins P. Bliss, dean of the engineering school, New York University. Up to about a year ago, the Index was a function of the American Society of Mechanical Engineers.

Dr. Jewett characterized the campaign for the preservation of Engineering Index as "one of the most important jobs confronting the profession today." He referred to the organization as "the only agency which makes available to the engineer and research worker an exhaustive and continuing record of findings and developments in the technical field."

"Soundly established, with adequate facilities for the exhaustive and systematic annotating and reporting of the findings in both pure and applied science, it will be insurance of continued and orderly progress and, as such, a national asset. Its support by industry is a matter of enlightened self-interest."

Sandusky Conservancy Program Awaits New Works Bill Plans

Application for final approval of plans for the proposed $36,000,000 Sandusky-Scioto conservancy program extending from Fremont to Portsmouth through central Ohio, will be held up until Congress passes the pending works and relief measure, according to Alan N. Jordon, executive secretary of the conservancy district. Recommendations for approval of the nine-dam program point out that they would: Restore the water table throughout central Ohio to old levels, prevent spring floods that have cost farmers in the section $2,500,000 a year, and would increase the value of agricultural production from $2,500,000 to $5,000,000 a year. Surveys indicate that farmers and industries would save nearly $3,000,000 annually in pumping costs if the program were in force.

State Control of County Roads Defeated in Washington

The Washington legislature on March 13 turned down the proposed new highway code for that state, which would have placed all of the county roads in the state highway system under unified control. The substitute measure virtually re-enacts the present highway law of the state. The bill provides that counties and cities receive three out of five cents of the gasoline tax. Cities, as a result, will receive about 30 per cent more than under the present system, the bill requiring $1.50 per capita to be turned over by the county to incorporated cities and towns.

County commissioners will retain control over construction and maintenance of secondary roads, and the only concession made in the new highway law to the state department requires the commissioners to file with the state highway director monthly reports on expenditures made. County commissioners, with the department's approval, can do road work by day labor up to $5,000. The bill appropriates $20,000,000 to match federal aid highway funds, with major allocations of $3,000,000 for primary road maintenance, $1,350,000 for emergency repairs on primary roads, $500,000 for unforeseen road damage, and $15,000,000 for secondary highways.

Permanent Soil Erosion Service Would Be Established by Bill

Establishment of the Soil Erosion Service of the Interior Department as a permanent government agency is sought in bills sponsored in the House by Representative Nichols, of Oklahoma. The service was created in September, 1933, by Secretary Ickes and its extensive demonstration projects throughout the country are financed by allotments totaling $20,000,000 from PWA funds. Because the service is an emergency unit that has no statutory status, the department's regular appropriation for the next fiscal year does not include any funds for erosion control but the work relief bill as reported to the Senate earmarks $350,000,000 for this purpose, together with reforestation and other conservation activities.

Approval of Hetch Hetchy Dam Raise by PWA Accompanied by Hearings on Power Sale

PLANS for raising Hetch Hetchy dam, on the San Francisco water supply system, to be financed by the PWA, have been approved by Administrator Ickes. The new work will increase the height of the structure from 344 ft. above the lowest point in the foundation to a height of 429 ft. The additional 85 ft. on the dam will increase the storage capacity in the reservoir almost 70 per cent. The original PWA allotment of $3,500,000 as a combined loan and grant for this work has been reduced, at the request of San Francisco, to a grant of $1,058,000.

The approving of this project by the PWA was taken as an occasion to challenge the existing arrangement for the sale of hydroelectric power produced as a part of the water supply development. At the present time, San Francisco wholesales the power produced at the Moccasin Creek plant to a local private utility, the Pacific Gas & Electric Co. This disposition of the power output of the development is considered a violation to the Raker Act, under which the city was permitted to construct the Hetch Hetchy Dam in Yosemite National Park, the act stipulating, according to Secretary Ickes, that the power developed may be sold only to municipalities or irrigation districts. The question raised by Secretary Ickes at this time merely brings to a head a problem of long standing and one well recognized by the municipality. For several years there have been active local advocates for the building of a public distribution system in San Francisco.

The Secretary has called a public hearing to be held May 6 in his office, to discuss the violation of the Raker Act.

Indiana Water Works Men Discuss Source, Distribution and Purification Problems

OF the sixteen papers presented at the meeting of the Indiana Section of the American Water Works Association on March 7 and 8, distribution and purification problems and the characteristics and effects of the recent drought were the topics receiving the bulk of attention. Other subjects discussed included waterworks planning, legislation affecting financing, customer handling and PWA progress.

On distribution system topics, W. C. Mabee, chief engineer of the Indianapolis Water Co., summarized the data in the report on standard specifications prepared for discussion by the A.W.W.A. committee on distribution system, G. Gale Dixon, chairman. F. C. Jordan, secretary of the Indianapolis Water Co., discussed a tentative report of another A.W.W.A. committee on markings of hydrants. There is a classification of hydrants into three grades: Class A, 1,000 g.p.m. or greater; class B, 500 to 1,000 g.p.m.; and class C, less than 500 g.p.m. The tops and nozzle caps are to be painted green, orange and red respectively for the A, B and C grades. Mr. Jordan was favorable to the report. He had held conferences with a dozen fire protection and prevention authorities and found all of them sympathetic.

Experiences with water main cleaning at Evansville, Ind., were described by Charles Streithof, superintendent of the water department. Large mains that had been laid before the filters were installed in 1913 were found to be 35 to 40 per cent filled with blue mud. The costs of removing the mud were given. Cyrus H. Bird, engineer of the Pitometer Company, made a plea for the proper planning of future extensions of mains, based on knowledge of past growth, present population, water consumption, fire-protection requirements and present carrying capacity of the system.

Purification subjects given attention at the meeting included one paper on filters, two on chlorination and one on conservation. A paper on the design of plants at the southern end of Lake Michigan was presented by Paul Hansen, consulting engineer. In it he outlined a number of reports that have been made on the pollution of lake waters. The indication is that in the absence of sewage treatment some water supplies are approaching the point of filter overloading. Except for Gary, which has a filter plant, all the cities in this section need filters.

W. H. Frazier, sanitary engineer, Indiana Conservation Department, stressed the need for a single agency to study and administer the water resources of the state. Some 40 per cent of the cities have no sewage treatment plants and 24 communities have questionable water supplies. He predicted ultimately some sort of national control.

Dr. V. K. Harvey, Indiana State Division of Public Health, gave the results of a study of typhoid epidemics caused by cross connections. H. S. Morse, general manager, Indianapolis Water Co., stated that the convention was meeting at the particular hotel only after a careful investigation of plumbing and approval by the State Division of Health.

H. O. Garman, consulting engineer, discussed the plight of the privately owned water plants which have difficulty in financing improvements. Municipally owned plants have been able through work relief crews to keep up their maintenance, and to finance through the PWA. The result has been to encourage municipal ownership.

The drought in Indiana is still a serious problem. F. C. Dillman, superintendent of the Bloomington water works, described his city's experiences with an impounded supply. J. H. Armington, meteorologist, U. S. Weather Bureau, predicted a larger rainfall for 1935. Although few people realize it, there is a decided water shortage now in many Indiana cities.

The newly elected officers for the ensuing year are as follows: President, C. K. Calvert; vice-president, B. A. Poole and secretary-treasurer John A. Bruhn, Indianapolis.

Two Timber Dams to Be Built By Quebec Streams Commission

At an estimated cost of $150,000, two new timber dams will be constructed this summer by the Quebec Streams Commission, one at Lake Aylmer to control the flow of the St. Francis River and the other at Lake Manouane to control the flow of the St. Maurice River.

The new dams will replace old ones which are no longer effective. Cost of the Lake Aylmer dam is set at $64,000, while that of Lake Manouane is set at $75,000. The money will come from the revenue of the commission which is derived from assessments on power companies and lumber companies benefiting from governmental control of water flow. Last year, the commission derived a total of $635,960 from this source.

Construction of the Lake Aylmer dam is already under way. Work on the new dam on Lake Manouane will start this spring.

SOCIETY CALENDAR

AMERICAN SHORE AND BEACH PRESERVATION ASSOCIATION, meeting, Miami, Florida, April 4-6.

NATIONAL RIVERS AND HARBORS CONGRESS, annual convention, Washington, D. C., May 2 and 3.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Cincinnati, Ohio, May 6-10.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Detroit, June 24-28.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Los Angeles, July 3-5.

FLORIDA SECTION, American Water Works Association, West Palm Beach, March 27-30.

CANADIAN SECTION, American Water Works Association, London, Ont., March 27-29.

SOUTHEASTERN SECTION, American Water Works Association, Birmingham, Ala., April 2-3.

ILLINOIS SECTION, American Water Works Association, Springfield, April 10-11.

MONTANA SECTION, American Water Works Association, Helena, April 10-11.

PENNSYLVANIA WATER WORKS OPERATORS' ASSOCIATION, annual meeting, State College, June 26-28.

List of Promotions Approved in Civil Engineer Corps of Navy

President Roosevelt has approved the recommendations of the selection board of the Civil Engineer Corps of the Navy under which Commander Ralph M. Warfield was promoted to the rank of captain. Fifteen lieutenant commanders were promoted to the rank of commander.

Capt. Warfield received his technical education at the Worcester Polytechnic Institute. Before entering the Navy he served as assistant professor of civil engineering at the University of Vermont and worked as an engineer for the Boston Bridge Works. He entered the Navy in 1907 as an assistant civil engineer. He has served at Charleston, New Orleans, Guam, Seattle, Boston, Pensacola, and Portsmouth. At present Capt. Warfield is public works officer at the Puget Sound Navy Yard. He was born in North Oxford, Mass.

The place of schooling, other than at the Naval Academy, is shown for the lieutenant commanders promoted to the rank of commander as follows. James T. Mathews, Rensselaer Polytechnic Institute; Paul J. Searles, Rensselaer Polytechnic Institute; Ben Moreell, University of Washington; Carl A. Trexel, University of Iowa; Alden K. Fogg, University of Illinois; Robert E. Thomas, University of Illinois; Edward C. Seibert, Baltimore Polytechnic Institute; William H. Smith, Massachusetts Institute of Technology; Edward L. Marshall, Tufts College; Willard A. Pollard, Jr., Lafayette College; John J. Manning, Troy, Rensselaer Polytechnic Institute; William M. Angas, Massachusetts Institute of Technology; Lewis B. Combs, Rensselaer Polytechnic Institute; Ira P. Griffin, Iowa State College; Carl H. Cotter, University of Michigan.

Changes in Personnel of Rhode Island Works Department

John H. Caton has been appointed chief of the division of roads and bridges of the Rhode Island department of public works. A graduate of Massachusetts Institute of Technology, his early work was with the civil service in the Philippines, and later with J. A. Latham & Company, of Providence. He was commander of the 33rd Engineers, A. E. F., during the War and remained in the army for some time after its close. He then became general manager of the Industrial Chemical Co., Providence, leaving that post to become director general of public works for the Republic of Santo Domingo. In 1925 he was chief engineer for R. W. Herbard & Co., Inc., New York, after which he was representative of Winston Brothers, Minneapolis, in Latin America. Lately Maj. Caton has been a PWA state engineer for Rhode Island.

Francis Chiaverini has been made chief of the division of public buildings in the Rhode Island department of public works. He practised engineering and architecture independently for ten years and for the past four years has been architect in the Providence public buildings department.

Dr. Lester A. Round has been appointed chief of the laboratory division of the Rhode Island department of public health. He was educated at Brown University and Harvard Graduate School of Public Health.

Personals

ALEXANDER BERNEY, superintendent of public works for the town of Reading, Mass., has resigned effective May 15.

W. M. REAM, formerly of Albuquerque, and O. C. ELAND have been appointed office engineer and office manager, respectively, of the Los Angeles County Flood-Control District, of which C. H. HOWELL is chief engineer. They were formerly associated with Mr. Howell in New Mexico.

JOHN B. BABCOCK, 3rd, for the past six years professor of railway engineering at the Massachusetts Institute of Technology, was elected president of the Boston Society of Civil Engineers at its annual meeting on March 20. Professor Babcock graduated from the Institute in 1910 in civil engineering and after six years of professional work returned as instructor in civil engineering at the Institute, and steadily advanced to full professorship.

Obituary

DIEUDONNE LE BLANC, for 30 years a contractor of Fitchburg, Mass., died in that city on March 11, at the age of eighty. He retired fourteen years ago.

EDWARD K. SMITH, formerly assistant manager of the highways and municipal bureau of the Portland Cement Association, died suddenly on March 9 in Beloit, Wis. He was graduated from the University of Wisconsin in 1913 and for ten years was first assistant city engineer of Beloit, going from there to PCA.

EUGENE E. PETTEE, since 1906 a member of the consulting engineering firm of J. R. Worcester & Co., Boston, Mass., died at his home in Wellesley Hills, Mass., on March 17 after a brief illness. He was born in Texas 65 years ago; was educated at the Massachusetts Institute of Technology, and after a short term of service with the Boston Bridge Works, joined the Worcester organization in 1896. He was a specialist in bridge design and construction.

WILLIAM S. SHIELDS, consulting civil and sanitary engineer, died March 7 in Chicago after an illness of three years. He was born in 1860, in Indiana County, Pa., and spent his early engineering career with John A. Cole on sanitary and hydraulic work. From 1893-1896 he maintained his own office as sanitary and municipal engineer, designing water plants and sewerage systems for several small Chicago suburban towns. He then became a member of the firm of Alvord and Shields, consulting engineers, which was dissolved in 1901. He maintained his own office until 1924, when he formed the firm of Shields, Jordan and Roe, later dissolved.

CONSTRUCTION STATISTICS OF THE WEEK

LOWER federal awards are principally responsible for lowering the volume of new engineering construction to $22,641,000 for the week, compared with $27,721,000 last week. Private work at $4,858,000 held practically at last week's volume. Public awards totaled $17,783,000, of which $15,901,000 was state and municipal work and $1,882,000 was federal construction.

Increases are recorded in waterworks at $2,040,000, and in sewerage at $2,049,000. Highway awards at $4,997,000 are at the same rate as last week. The following totals are below the total of a week ago in the same classifications: bridges, $1,156,000; industrial buildings, $1,063,000; commercial buildings, $607,000; public buildings, $5,556,000; unclassified, $4,604,000.

The larger projects for the week include: armory for Minneapolis Armory Bldg. Comn., Minneapolis, Minn., $557,000; generators for Columbus and Monroe Power Houses for Loup River Public Power District, Columbus, Nebr., $618,000; state highway lettings, $526,000 by Georgia and $483,000 by Iowa; submarine section, Bay crossing, Pipeline No. 2 for City and County of San Francisco, Calif., $698,000; contract No. 3, structure and equipment for Coney Island Sewage Treatment Works, Brooklyn, N. Y., $1,179,000; pier 25, New York, N. Y., $367,000; pier shed and bulkhead shed for pier 45, New York, N. Y., $587,000; 3,600 tons steel for 89 mi. gas pipe line from Lebec to Torrance, by General Petroleum Corp., Los Angeles, Calif., $1,000,000, and rails and track accessories for New York Central R. R., New York, N. Y., $1,729,000.

New capital for the week consists of $4,716,000 in bond sales, together with an increase of $306,000 in PWA allotments.

CONTRACTS

(Thousands of Dollars)

	Weekly Average Mar. 1934	Prev. 4 Weeks	Week Mar. 21 1935
Federal Government	$9,000	$3,269	$1,882
State and municipal	13,413	12,857	15,901
Total public	$22,413	$16,126	$17,783
Total private	7,028	4,919	4,858
Week's total	$29,441	$21,045	$22,641
Cumulative to date:			
1934...$355,846,000	1935...$289,514,000		

NEW PRODUCTIVE CAPITAL

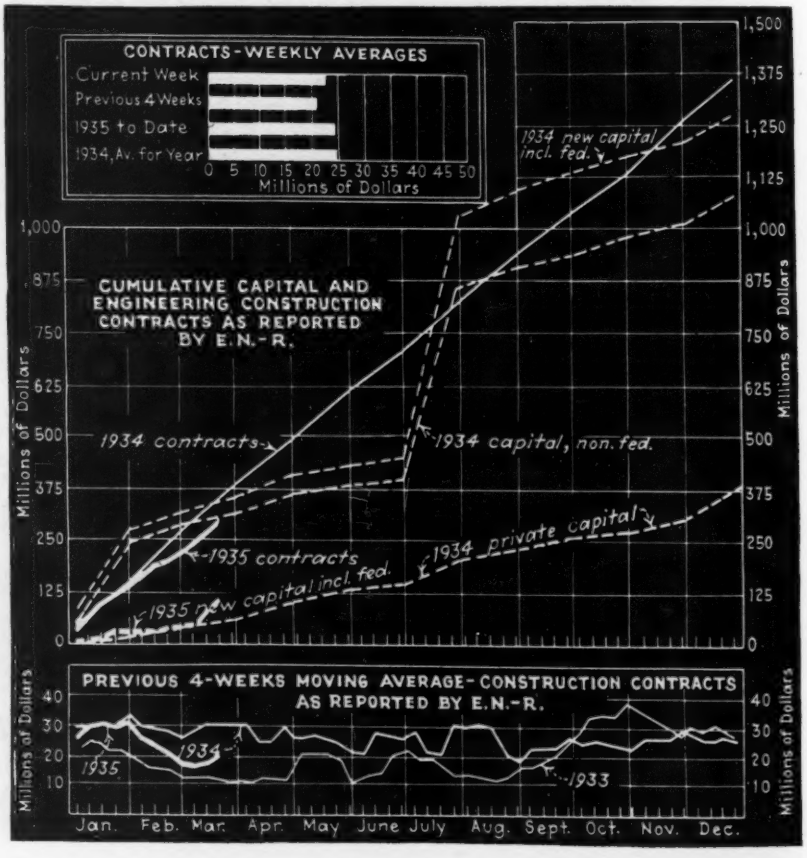
(Thousands of Dollars)

1935	Week Mar. 21	Cumulative
State and municipal	$4,716	$104,400
PWA allotment, S&M	306	—33,404
RFC loans, S&M	....	84
Corporate issues	....	....
PWA allotments, private	....	....
Total, Non-Federal	$5,022	$78,389
PWA allotments, Federal Constr.	312	8,270
Total new capital	$5,334	$86,659
Cumulative to date:		
1934...$350,581,000	1935...$86,659,000	

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction.

INDEX NUMBER

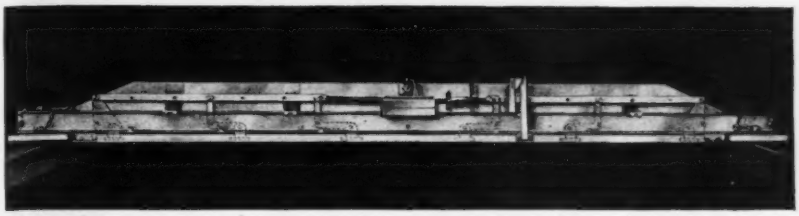
E.N.R.-Cost	1913 = 100	1926 = 100	E.N.R.-Volume	1913 = 100	1926 = 100
Mar., 1935	193.46	93.00	Feb., 1935	76	33
Feb., 1935	196.02	95.52	Jan., 1935	130	57
Mar., 1934	194.06	93.20	Feb., 1934	116	51
1934(Av.)	198.10	95.23	1934(Av.)	114	50
1933(Av.)	170.18	81.80	1933(Av.)	102	47
1932(Av.)	156.97	75.45	1932(Av.)	127	56



Construction Equipment and Materials

Adjustable Highway Screed For Eliminating Crown on Curves

Because a great many state highway departments require the flattening of a pavement surface around curves, the Blaw-Knox Co., Pittsburgh, Pa., has developed the Quick Adjustable Screed for crown elimination. It can be installed on any Blaw-Knox finishing machine and can be used for either concrete or bituminous road construction.



Adjustable screed allows transition to be made from full crown to flat pavement surface around curve

The new screed remains in the finisher for both the crown and the flat section. By the use of cam levers and the operating spider, it can be gradually flattened or crowned while going through the paving transition without job delay. The adjustment in crown is made while the finisher is in operation by turning the adjusting spider device. A gage indicates the degree of change and the true crown.

Pump for Sewage Sludge Reduces Agitation to Minimum

A new pump for handling sewage sludge has been announced by the Novo Engine Co., Lansing, Mich. The pump is especially designed to avoid as much agitation as possible and to allow long periods of service between cleanings.

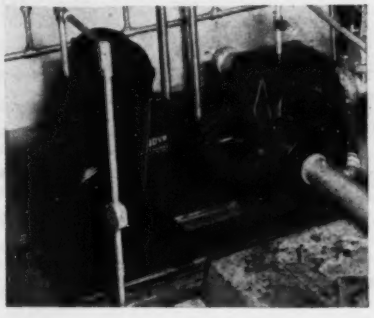
The manufacturer states that the practically straight line gravitational flow of the sludge from top to bottom through the pump combined with a comparatively slow speed of the plunger produces an even flow of sludge without agitation. The large valve area, 21.6 sq.in., allows long periods of operation without cleaning.

When cleaning does become necessary, it is accomplished by removing a 1 in. plug at the top of the pump and flushing it through with water. A 2 in. drain plug at the bottom of the pump is provided. By allowing the pump to operate a few strokes it can be cleaned without removing the handhole plates or valves.

The sealing of the plunger is accomplished by two rolling rubber rings on the plunger which roll with the forward and backward motion of the piston and as they are pressed against the cylinder wall and plunger make a liquid-tight seal.

The power unit is a 3 hp. electric motor with V-belt drive. Portable installations are furnished with gasoline engine power and truck mounting.

Novo Engine Co.'s new sludge pump



Synthetic Puzzolana for Greater Concrete Durability

In an attempt to aid in the production of more durable concrete, the Master Builders Co., Cleveland, Ohio, has developed a new concrete admixture known as Pozzolith, a gelatinous colloid of high puzzolanic properties. The active puzzolanic ingredient is Omicron, a synthetic puzzolana, which is claimed to beact more rapidly and more completely with lime than any known puzzolanic material. Adding Pozzolith to any well-balanced concrete mix is claimed to permit reducing the water content by 10 per cent or more and at the same time maintaining proper workability. By decreasing the water-cement ratio, the use of Pozzolith is claimed to reduce the shrinkage in concrete, increase its corrosive resistance to sodium sulphate solutions, increase resistance to freezing and thawing and increase compressive strength. It is recommended that Pozzolith be added to the concrete mix in the proportions of not less than 1½ pints per sack of cement, and in no event (for lean mixes) less than one gallon per cubic yard of concrete. The volume of water may be reduced by as much as the volume of Pozzolith added and apparently by as much more as tests indicate is practicable.

Business Notes

IDEAL ELECTRIC & MANUFACTURING CO., Mansfield, Ohio, announces that Ray P. Tarbell has been appointed manager of the welding division.

D. W. HAERING & CO., INC., Chicago, Ill., announce the removal of their Detroit office to the Fisher Building and the appointment of Franklin W. Murray as district manager.

WORTHINGTON PUMP & MACHINERY CORP., Harrison, N. J., announces that it has consolidated several of its contributing sales divisions into one mining and construction department under the management of W. A. Neill, with headquarters at its general offices.

New Equipment in Brief

Centrifugal Pump. The two-stage Monobloc centrifugal pump has been announced by the Worthington Pump & Machinery Corp., Harrison, N. J. The manufacturer states that it is applicable to all services requiring small capacity and medium discharge head. The casing, designed to withstand 150 lb. pressure, is bolted directly to the motor frame without an intermediate distance piece, eliminating the necessity for a base plate.

High-Pressure Pump. A specially designed pump for extremely high lifts or a high-pressure water supply has been announced by the Byron Jackson Co., Berkeley, Calif. The pump, known as the Hydropress, is of the centrifugal type. It permits the building of pressures up to 2,800 lb. per square inch. The number of stages ranges from 4 to 54, depending on conditions. The capacity ranges from 10 to 250 g.p.m. Four standard sizes are available: 8-in., 10-in., 12-in., and 15-in.

Hard Surfacing Electrode. A new hard-surfacing electrode designed for building up straight carbon steel, low-alloy or high-manganese steel surfaces to resist abrasion is announced by the Lincoln Electric Co., Cleveland, Ohio. The new electrode, known as "Abrasoweld," the manufacturer states, will be found of value in such applications as restoring teeth, lips and bottoms of power shovels; lugs and treads of tractors; housings and impellers of centrifugal sand pumps; rock crushing equipment; and gear and pinion teeth.

New Publications

ATLAS EXPLOSIVES, Atlas Powder Company, Wilmington, Del., 5½x8½, 32 pages.

POWER VANE ROTARY TOOLS, Chicago Pneumatic Tool Co., New York, N. Y., 8½x11, 16 pages.

THE FIRE RESISTANCE OF GYPSUM PLASTER, Gypsum Association, Chicago, Ill., 8½x11, eight pages.

KRANE KAR, Silent Hoist Winch & Crane Co., Brooklyn, N. Y. 8½x11, 12 pages. Bulletin No. 45.

"FLEX-SET" PREFORMED YELLOW STRAND WIRE ROPE, Broderick & Bascom Rope Co., St. Louis, Mo., 5½x8½, 19 pages.

STANDARD SPECIFICATIONS FOR GYPSUM PLASTERING, Gypsum Association, Chicago, Ill., 8½x11, 12 pages.

LUNKENHEIMER "CAUSUL" METAL GATE VALVES, The Lunkenheimer Co., Cincinnati, Ohio, 8½x11, eight pages.

BUCKET ELEVATORS, the Jeffrey Manufacturing Co., Columbus, Ohio, 8½x11, 110 pages. Catalog No. 565.

AIR-COOLED TRANSFORMERS, General Electric Co., Schenectady, N. Y., 8½x11, 18 pages.

PLUS PORTABLE TWO STAGE AIR-COOLED COMPRESSORS, Sullivan Machinery Company, Chicago, Ill., 32 pages.

PRESERVATION WITH No-D-K, Tennessee Eastman Corporation, Kingsport, Tenn., 8½x11, 16 pages. A discussion of wood preservation.

CHAINS AND SPROCKETS FOR POWER TRANSMISSION, Conveying and Elevating, Baldwin-Duckworth Chain Corp., Springfield, Mass., 54 pages, pocket size. Catalog K-1.

HELTZEL STEEL FORMS, Heltzel Steel Form & Iron Co., Warren, Ohio, 8½x11, eight pages. Bulletin 200. Steel Forms for Building Curb, Gutter and Sidewalk.

WORTHINGTON DIESEL ENGINES, Worthington Pump & Machinery Corporation, Harrison, N. J., 8½x11, 16 pages. Bulletin S-500-B6D.

ENDURO 18-8, Republic Steel Corporation, Massillon, Ohio, 8½x11, 16 pages. Stainless steel and its uses.

NICHOLS HERRESHOFF INCINERATOR, Nichols Engineering & Research Corp., New York, N. Y., 7½x11, eight pages. Bulletin No. 202, describing an incinerator designed for the incineration of sewage sludge.

Current Construction Unit Prices

Fort Peck Dam Transmission Line

CONTRACT was awarded in April, 1934, for the construction of the 287-mile, 3-phase, 154,000-volt power line running from the Rainbow substation of the Montana Power Company near Great Falls to the Ft. Peck Dam Site. Alternates were taken on copper conductor line and aluminum cable steel reinforced, with contract awarded on the latter basis to Fritz Ziebarth and H. H. Walker, Inc., Los Angeles, Cal. Completion was scheduled for 150 days after award of contract with PWA minimum wage rates prevailing of $1.50 for skilled and $.50 for common labor. Following are the alternate comparisons with the totals and unit prices of the three lowest bidders. All work at Ft. Peck is under the direction of the U. S. Corps of Engineers. Maj. Thos. B. Larkin is district engineer.

LIST OF BIDDERS AND TOTAL BIDS

	Copper Conductor Cable	Aluminum Steel Reinforced Cable
A—Fritz Ziebarth and H. H. Walker, Inc., Los Angeles, Cal. (contract)	$1,072,986.00	$1,057,236.00
B—A. S. Schulman Elec. Co., Chicago, Ill.	1,182,154.00	1,140,263.00
C—Addison Miller, Inc., St. Paul, Minn.	1,185,020.00	1,170,172.00

POWER TRANSMISSION LINE—FT. PECK DAM

A—Aluminum Cable Steel Reinforced Conductor Line Alternate.
C—Copper Conductor Line alternate.

	A	B	C
1C—Poles, 75 ft. length—25	$51.20	$53.65	$60.57
A— " " " —25	53.52	56.27	64.00
2C—Poles, 70 ft. length—112	46.79	50.57	56.00
A— " " " —23	46.79	50.60	56.12
3C—Poles, 65 ft. length—10	38.83	43.54	48.00
A— " " " —110	40.72	45.52	50.75
4C—Poles, 60 ft. length—212	38.40	40.23	43.50
A— " " " —105	36.69	42.10	46.00
5C—Poles, 55 ft. length—5,040	31.40	37.30	38.95
A— " " " —1,336	34.63	40.00	42.25
6C—Poles, 50 ft. length—254	27.45	33.83	34.00
A— " " " —3,459	30.57	35.75	37.60
7C—Poles, 45 ft. length—51	23.76	31.62	29.00
A— " " " —149	26.42	22.33	32.15
8C—Poles, 40 ft. length—25	19.11	26.48	22.00
A— " " " —27	21.56	28.72	25.00
9A—Poles, 35 ft. length—25	17.13	24.77	19.60
10C—Poles, 15 ft. length, 15-in. top dia.—55	11.04	19.49	17.75
A— " " " " " —55	11.04	19.51	17.75
11C—Holes in earth—31,200 l.f.	0.424	0.81	0.50
A— " " " —29,100 l.f.	0.424	0.831	0.50
12C—Holes in solid rock—7,800 l.f.	0.643	1.47	1.10
A— " " " " 7,300 l.f.	0.643	1.49	1.10
13C—Cross Arms, untreated—402 M.f.b.m.	76.25	63.40	67.00
A— " " " —407 M.f.b.m.	73.20	62.65	68.00
14C—Hardware, Class I —70,600 lb.	0.112	0.141	0.14
A— " " —70,100 lb.	0.11	0.141	0.14
15C—Hardware, Class II—54,100 lb.	0.15	0.20	0.16
A— " " —53,600 lb.	0.15	0.20	0.16
16C—Guy cable—57,250 lb.	0.114	0.155	0.20
A— " " —63,786 lb.	0.114	0.155	0.20
17C—Anchors in earth—1,105	5.22	13.39	9.00
A— " " " —1,167	5.22	12.51	9.00
18C—Anchors in solid rock—200	7.40	14.69	9.00
A— " " " " —200	7.40	14.66	9.00
19C—Conductor cable, copper—4,303,186 lb.	0.143	0.147	0.152
A—Conductor cable, A.C.S.R.—2,852,377 lb.	0.21	0.213	0.225
20C—Cable splices—2,000	3.26	6.47	4.10
A— " " —725	5.35	7.164	6.50
21C—Cable splicing devices—7	254.19	193.74	153.00
A— " " " —7	474.05	538.46	460.00
22A—Stock Bridge dampers—444	3.876	3.476	3.75
23C—Insulator string, 8 unit—7,797	18.514	18.10	19.75
A— " " " —7,002	21.62	21.046	23.25
24C—Insulator strings, 9 unit susp.—414	21.50	20.02	22.30
A— " " " " —571	23.91	21.886	25.75
25C—Insulator strings, 9 unit strain assembly —216	22.32	20.86	23.35
26A—Insulator strings, 8 unit strain assembly —228	28.96	29.50	31.75
27C—Sectionalizing switches—5 each	2,153.98	1,630.25	2,340.00
A— " " —5 each	2,153.98	1,630.25	2,340.00
28C—Section switch tower enclosures—5 each	337.77	343.11	450.00
A— " " " —5 each	337.80	343.13	400.00
29C—Grounding, Class I—5,617 each	0.654	3.00	0.95
A— " " —5,147 each	0.783	3.19	0.95
30C—Grounding, Class II—5 each	44.58	69.78	63.00
A— " " —5 each	60.53	85.49	63.00
31C—Grounding, Class III—2 each	1,310.84	2,104.09	1,600.00
A— " " —2 each	1,325.64	1,887.50	1,415.54
32C—Clearing, grubbing—10,000 squares	0.233	1.37	0.20
A— " " —10,000 squares	0.233	1.37	0.20
33C—Spare parts and tools—sets	1,353.53	1,303.20	1,472.00
A— " " " —7 sets	1,456.45	1,030.61	1,410.00

Dam No. 10, Upper Mississippi River

CONTRACT was awarded in early January for the construction of Dam 10 near Guttenberg, Iowa, forming another link in the navigation development of the upper Mississippi Rver. Remarkably close bidding is found in the eight proposals, varying from the contract low of $1,946,076 to a high of $2,108,624. The dam is similar in construction to the previous types and its length including the movable gate, concrete spillway and earth dikes approximates 6,510 ft. Following are unit prices and totals for the three lowest bidders. (A)—McCarthy Improvement Co., Davenport, Ia. (contract) $1,946,076; (B) Engineering Const. Corp., New York, $1,973,592; (C) Merritt-Chapman & Whitney Corp., New York, $1,987,746.

DAM NO. 10, UPPER MISSISSIPPI RIVER IMPROVEMENTS

Item		A	B	C
1.	Coffer dam—815.5 l.f.	$298.00	$207.00	$220.00
2.	Excavation, common—54,000 cu.yd.	0.30	0.50	0.56
3.	Excavation, dredged—245,000 cu.yd.	.197	.19	.30
4.	Excavation, top soil—57,000 cu.yd.	.30	.30	.30
5.	Fill—17,000 cu.yd.	.28	.30	.50
6.	Dike embankment—297,000 cu.yd.	.26	.16	.30
7.	Clearing—19.6 acres	100.00	50.00	125.00
8.	Timber piles, vertical—127,500 l.f.	.60	0.55	0.60
9.	Timber piles, batter—6,250 l.f.	1.00	1.00	0.90
10.	Concrete piles—3,200 l.f.	3.00	2.50	3.50
11.	Steel sheet piles—184,300 s.f.	1.30	1.45	1.35
12.	Pile load tests—5	430.00	700.00	800.00
13.	Timber, oak—2.13 M.f.b.m.	160.00	200.00	220.00
14.	Timber, creosoted y.p.—46 M.f.b.m.	120.00	150.00	130.00
15.	Stone, protection, derrick—8,500 cu. yd.	3.30	4.15	4.00
16.	Stone, protection, riprap—33,700 cu. yd.	2.75	3.30	3.75
17.	Gravel, embankment protection—23,200 cu.yd.	2.35	2.75	2.45
18.	Concrete, Cl. A—530 cu.yd.	23.50	25.00	25.00
19.	Concrete, Cl. B—43,400 cu.yd.	10.97	12.00	11.00
20.	Structural steel, service bridge—1,050,000 lb.	.0565	.06	.06
21.	Struct. steel, tainter gate, movable parts—725,000 lb.	.0615	.06	.056
22.	Struct. steel, roller gate, movable parts—995,000 lb.	.0595	.07	.07
23.	Struct. steel, misc.—940,000 lb.	.069	.06	.077
24.	Reinforcing steel—1,635,000 lb.	.043	.05	.05
25.	Steel, corrosion resisting—21,000 lb.	.50	.50	.50
26.	Carbon steel forgings—91,500 lb.	.085	.08	.085
27.	Alloy and nickel steel—26,800 lb.	.15	.13	.107
28.	Castings, Class B steel—235,000 lb.	.135	.13	.115
29.	Castings, iron semi-steel, malleable—3,050 lb.	.07	.13	.07
30.	Bronze and brass—5,600 lb.	.41	.41	.31
31.	Copper—850 lb.	.51	1.00	.60
32.	Metals, non-ferrous, lead, zinc—35 lb.	.46	2.00	.40
33.	Metal shoes, timber piles—100	1.45	5.00	1.78
34.	W. I. pipe, black std. wgt., 6 in—2021 l.f.	1.75	3.50	3.00
35.	" 3 in.—3581 l.f.	1.05	2.50	1.50
36.	" ext. heavy, ½ in.—201 l.f.	.72	2.00	1.25
37.	" std. wt. 1 in.—251 l.f.	.80	2.00	1.40
38.	Std. copper tubing, 1 in.—8751 l.f.	.50	1.00	1.00
39.	Fiber conduit, 3 in.—430 l.f.	.40	.50	.36
40.	Rigid metal conduit, ¾-in.—251 l.f.	.50	.70	.21
41.	" 1-in.—1,000 l.f.	.52	.80	.23
42.	" 1¼-in.—2701 l.f.	.60	.90	.32
43.	" 1½-in.—800 l.f.	.80	1.00	.35
44.	" 2-in.—2201 l.f.	1.10	1.20	.48
45.	" 2½-in.—1701 l.f.	2.05	2.00	.69
46.	" 3-in.—1601 l.f.	2.30	2.50	.90
47.	Elect. grounding system (Lump sum)	300.00	350.00	214.00
48.	Crane track, 80 lb. with fastenings—963 track ft.	3.45	3.25	2.35
49.	Handrail, steel pipe, complete, service bridge—1,2551 l.f.	1.55	2.50	2.00
50.	Handrail, roller gate—3101 l.f.	1.55	1.00	1.00
51.	Floor grating steel, weld or rivet—870 s.f.	.80	.75	.87
52.	Rubber seals, moulded—3,800 lb.	.97	.65	.85
53.	Operating mchy. roller gate, complete—4, each	14,500.00	15,000.00	13,000.00
54.	Roller gate mchy. spare parts—Lump sum	10,150.00	6,000.00	4,500.00
55.	Roller gate operating house, complete —5 each	5,000.00	5,000.00	4,870.00
56.	Operating mchy. tainter gate, complete—8 each	6,200.00	7,000.00	5,200.00
57.	Tainter gate, spare parts—Lump sum	2,700.00	600.00	600.00
58.	Tainter gate mchy. spare parts—Lump sum.	6,000.00	5,000.00	2,000.00
59.	Gate heaters, tainters—8, per gate.	300.00	350.00	210.00
60.	Gate heaters, roller, complete—4, per gate.	1,600.00	2,300.00	1,500.00
61.	Install locomotive crane, service bridge —Lump sum.	1,400.00	1,000.00	1,000.00
62.	Flat car—1	1,350.00	1,000.00	920.00
63.	Tainter gate, aeration system—Lump sum	1,300.00	1,200.00	1,665.00